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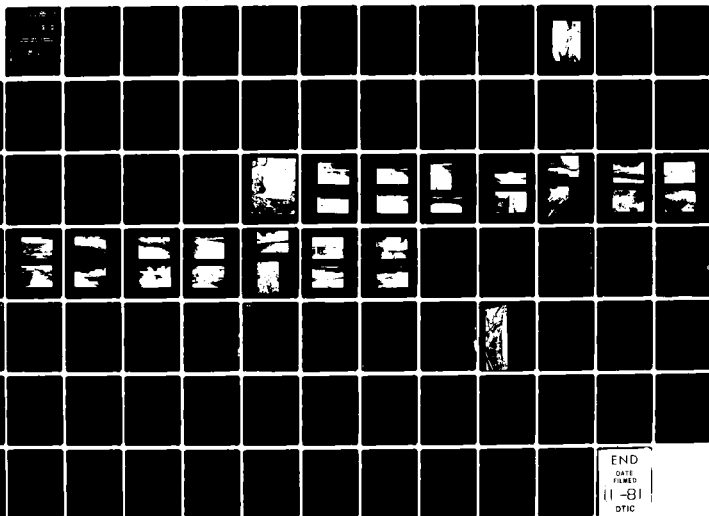
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MACON LAKE DAM
MACON COUNTY, MO.
MO 10153

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PHASE 1 INSPECTION REPORT NATIONAL DAM SAFETY PROGRAM

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St. Louis District

PREPARED BY: U.S. ARMY ENGINEER DISTRICT, ST. LOUIS

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OCTOBER, 1980

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MACON COUNTY, MISSOURI
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PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

PREPARED BY
HOSKINS-WESTERN-SONDEREGGER, INC.
CONSULTING ENGINEERS
LINCOLN, NEBRASKA

UNDER DIRECTION OF
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
FOR
GOVERNOR OF MISSOURI

OCTOBER, 1980



REPLY TO
ATTENTION OF

DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 TUCKER BOULEVARD, NORTH
ST. LOUIS, MISSOURI 63101

SUBJECT: Macon Lake Dam - MO 10153

This report presents the results of field inspection and evaluation of the Macon Lake Dam. It was prepared under the National Program of Inspection of Non-Federal Dams.

SUBMITTED BY: SIGNED
Chief, Engineering Division

2 FEB 1981
Date

APPROVED BY: SIGNED
Colonel, CE, District Engineer

3 FEB 1981
Date

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

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PHASE I REPORT
NATIONAL DAM SAFETY PROGRAM
ASSESSMENT SUMMARY

Name of Dam	Macon Lake Dam
State Located	Missouri
County Located	Macon County
Stream	Duck Creek
Date of Inspection	October 8, 1980

Macon Lake Dam was inspected by an interdisciplinary team of engineers from Hoskins-Western-Sonderegger, Inc. The purpose of the inspection was to make an assessment of the general conditions of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.

The guidelines used in the assessment were furnished by the Department of the Army, Office of the Chief of Engineers and developed with the help of several Federal and State agencies, professional engineering organizations, and private engineers.

Macon Lake Dam has a height of Forty-two (42) feet and a storage capacity at the minimum top elevation of the dam of four thousand four hundred (4,400) acre-feet. In accordance with the guidelines, an intermediate size dam has a height greater than or equal to forty (40) feet but less than one hundred (100) feet and a storage capacity greater than or equal to one thousand (1,000) acre-feet but less than fifty-thousand (50,000) acre-feet, whichever gives the larger size category. Macon Lake Dam is classified as an intermediate size dam.

In accordance with the guidelines and based on visual observation, the dam is classified as having a high hazard potential. Failure would threaten life and property. The estimated damage zone extends approximately ten (10) miles downstream of the dam. Within the damage zone are portions of the city water treatment plant, the municipal swimming pool, 4 or 5 dwellings and U.S. Highway 36 immediately downstream from the dam; the C. B. and Q. railroad about 1 mile downstream; and one dwelling about 2 miles downstream. Minimal damage will occur beyond the first 2 miles of the estimated 10 mile damage zone.

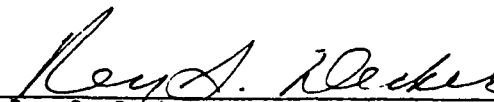
Our inspection and evaluation indicate that the spillway does not meet the minimum criteria set forth in the recommended guidelines for an intermediate dam having a high hazard potential. The Probable Maximum Flood is the appropriate spillway design flood. The spillway will pass the 100-year flood (a flood having a 1 percent probability of being exceeded in any year) without overtopping the dam. The spillway will pass 55 percent of the Probable Maximum Flood without overtopping the dam. The Probable Maximum Flood (PMF) is defined as the flood that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region.

Construction plans were available for this dam. Data collected during the field inspection as well as data from the plans were used in the analysis of this dam. Based on this analysis the following remedial measure should be implemented by the owner on a high priority basis:

- (a) The height of the dam should be increased and/or the spillway size or shape should be changed to pass the Probable Maximum Flood without overtopping the dam.

The following operation and maintenance procedures are recommended and should be implemented by the owner in the near future.

- (a) Seepage and stability analyses comparable to the requirements of the recommended guidelines should be performed by an engineer experienced in the design and construction of the dams.
- (b) The major cracks and holes in the concrete spillway channel and drop structures should be repaired.
- (c) The small trees (saplings) and shrubs growing on the upstream slope should be removed and measures taken to prevent their recurrence.
- (d) A program of periodic inspection and maintenance, with particular attention to the spillway, should be initiated and the inspection records made a part of this project file.



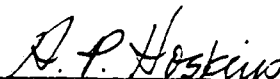
Rey S. Decker
E-3703



Gordon Jamison



Garold Ulmer
E-19246



Harold P. Hoskins, Chairman of the Board
Hoskins-Western-Sonderegger, Inc.
E-8696



PHOTO NO. 1 - OVERVIEW

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
MACON LAKE DAM - MO 10153
MACON COUNTY, MISSOURI

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

- a. Authority. The National Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army through the Corps of Engineers, to initiate a program of safety inspection of dams throughout the United States. Pursuant to the above, the St. Louis District, Corps of Engineers, District Engineer directed that a safety inspection of Macon Lake Dam be made.
- b. Purpose of Inspection. The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.
- c. Evaluation Criteria. Criteria used to evaluate the dam were furnished by the Department of the Army, Office of the Chief of Engineers, in "Recommended Guidelines for Safety Inspection of Dams", Appendix D to "Report of the Chief of Engineers on the National Program of Inspection of Dams", dated May, 1975, and published by the Department of the Army, Office of the Chief of Engineers.

1.2 DESCRIPTION OF PROJECT

- a. Description of Dam and Appurtenances.
 - (1) Embankment. The dam is an earthfill structure approximately 1,200 feet in length and 42 feet in height. The dam impounds a normal pool of about 2,250 acre-feet. The maximum storage at the minimum top elevation of the dam is 4,400 acre-feet.
 - (2) Spillway. The only spillway is located in the right abutment of the dam. It consists of a concrete ogee weir and a trapezoidal shaped concrete lined downstream channel. The circular segment of the channel shown on Plate C-3 was constructed in 1928. Later (date unknown) the concrete lined channel was extended another 192 feet + downstream (See Plate C-2). The later construction incorporated drop structures in the channel, the first of which was constructed at the end of the original channel (3.5 feet+). The second drop (7.6 feet+) was constructed 107 feet + downstream and the third (3.6 feet+) was constructed at the end of the

channel. The total drop from the top of the weir to the end of the concrete channel is 30 feet+. The channel is uniformly tapered from the weir length of 85 feet to a width of 45 feet at the bottom end of the lined channel where spillway flows discharge into a vegetated earth channel.

- (3) Low-Level Outlets. Two low-level outlet lines are shown on the plans for this dam. A 12-inch cast iron suction line originating at the bottom of the gate chamber is used to draw off water to the water treatment plant. A 6-inch cast iron gravity line also originates at the bottom of the gate chamber. It functions as a cleanout or flushing line, and water drawn off through this line is wasted. Both lines are controlled by sluice gates. Entrance of water into the gate chamber is controlled by three 12-inch sluice gates mounted at different elevations. The lowest of the three is mounted 5 feet above the invert elevations of the 6 and 12-inch outlet lines. Plates C-2, C-5 and C-7 show these details.

- (4) Pertinent physical data are given in paragraph 1.3.

- b. Location. The dam is located approximately one and one-half miles northwest of Macon in Macon County, Missouri as shown on Plate A-2. The dam is shown on Plate A-1 in the NW1/4 of Section 17, T57N, R14W.
- c. Size Classification. Criteria for determining the size classification of dams and impoundments are presented in the guidelines referenced in paragraph 1.1c above. Macon Lake Dam has a height of 42 feet and a maximum storage capacity at minimum top elevation of dam of 4,400 acre-feet. This dam is classified as an intermediate size dam. An intermediate size classification is determined by either the storage or height, whichever gives the larger size category.
- d. Hazard Classification. Guidelines for determining hazard classification of dams and impoundments are presented in the guidelines as referenced in paragraph 1.1c above.

Aerial photographs of the downstream damage zone of this dam were taken in October, 1980. These photographs were used as reference in the field observations of the damage zone which were made during the inspection. Based on the field observations and on the referenced guidelines this dam is in the High Hazard Potential Classification. The estimated damage zone extends approximately ten miles downstream of the dam. Within the damage zone are portions of the City water treatment plant, the municipal swimming pool, U.S. Highway 36 and 4 or 5 dwellings immediately downstream from

the dam, the C. B. & Q. railroad about 1 mile downstream and one dwelling about 2 miles downstream. Minimum damage will occur beyond the first 2 miles of the estimated 10 mile damage zone.

- e. Ownership. The dam is owned and operated by the City of Macon, 121 West Bourke, Macon, Missouri 63552.
- f. Purpose of Dam. The dam impounds water used by the City of Macon as a municipal water supply. The lake also provides recreational benefits.
- g. Design and Construction History. The dam was designed by Burns and McDonnell of Kansas City. The plans for the dam are included in Appendix C of this report. The plans are dated 1927. Notes on the plans indicate corrections were made in April, 1928. Construction was completed in 1928. Mr. Paul Jensen, General Superintendent of Macon Municipal Utilities, stated that the spillway weir was raised approximately 2 feet in 1964. The concrete lined spillway exit channel has been extended since the initial construction. The date of this construction is not known.
- h. Normal Operating Procedure. Water for the City of Macon is drawn from the reservoir through a 12-inch cast iron suction line. Water can also be withdrawn by gravity through a 6-inch cast iron pipe flushing line. Except for the demand for potable water by the city, the pool level is controlled by rainfall, infiltration, evaporation and the capacity of the uncontrolled spillway.

1.3 PERTINENT DATA

- a. Drainage Area. 4,048 acres (6.32 square miles)
- b. Discharge at Damsite
 - (1) All discharges at the damsite are through the following:
 - (a) An uncontrolled spillway consisting of an 85 foot length concrete ogee weir which discharges into a trapezoidal shaped concrete lined exit channel.
 - (b) A 12-in cast iron suction line used to draw off water for municipal use.
 - (c) A 6-inch cast iron pipe gate chamber cleanout or flushing line.
 - (2) Estimated maximum flood at damsite -- unknown.
 - (3) The spillway capacity varies from 0 c.f.s. at elevation 791.9 feet to 6,350 c.f.s. at the minimum top of dam (elevation 799.9 feet).

- (4) Total spillway capacity at the minimum top of dam is 6,350 c.f.s. \pm .

c. Elevations (feet above M.S.L.).

- (1) Observed pool - 787.7
- (2) Normal pool - 791.9
- (3) Spillway crest - 791.9
- (4) Maximum experienced pool - 793.9 \pm (based on Mr. Jensen's statement that there has been as much as 2 feet of flow in the spillway).
- (5) Top of dam (minimum) - 799.9
- (6) Streambed - 758 \pm (from plans)
- (7) Maximum Tailwater - unknown

d. Reservoir. Length (feet) of pool

- (1) At spillway crest - 9,200 \pm
- (2) At top of dam (minimum) - 13,700 \pm

e. Storage (Acre-feet).

- (1) Observed pool - 1,500 \pm
- (2) Normal pool - 2,250 \pm
- (3) Spillway crest - 2,250 \pm
- (4) Maximum experienced pool - 2,700 \pm
- (5) Top of dam (minimum) - 4,400 \pm

f. Reservoir Surface (Acres).

- (1) Observed pool - 160 \pm
- (2) Normal pool - 205 \pm
- (3) Spillway crest - 205 \pm
- (4) Maximum experienced pool - 235 \pm
- (5) Top of dam (minimum) 340 \pm

g. Dam.

- (1) Type - Earth fill
- (2) Length - 1,200 ft. \pm
- (3) Height - 42 ft. (maximum, from plans)
- (4) Top Width - 11 ft. \pm
- (5) Side slopes
 - (a) Downstream - 1V on 2.8 \pm H (1V on 2H, plans)
 - (b) Upstream - 1V on 2.4 \pm H (1V on 2.5H, plans)
- (6) Zoning - None
- (7) Impervious core - None
- (8) Cutoff - Plans show concrete cut-off wall across main stream channel (Sta. 6+48 to 6+93) and a clay cut-off wall with 8 ft. bottom width (Sta. 8+50 to 10+00).
- (9) Grout curtain - None
- (10) Wave protection - Limestone, concrete and asphaltic concrete rubble riprap - nominal size 6".
- (11) Drains - None

h. Diversion Channel and Regulating Tunnel. None

i. Spillway.

- (1) Type - A vegetated earth approach to a spillway structure constructed in the right abutment. The structure consists of a concrete ogee weir and a trapezoidal shaped concrete exit channel.
- (2) Control section - Concrete ogee weir - 85 feet in length.
- (3) Crest elevation - 791.9 (Plans show 790. Crest elevation raised 2 feet \pm in 1964).
- (4) Upstream Channel - Vegetated earth between walls of spillway structure. The channel is unobstructed. The plans for the structure show concrete pavement between the walls. No plans were available for the 1964 modification when the

elevation of the weir was raised 2 feet. It is not known whether the concrete pavement is still in place.

- (5) Downstream Channel - Trapezoidal shaped concrete exit channel is open and clear of obstructions. Earthen channel downstream from concrete exit channel is tree lined with some small trees and weed growth in the channel.
- j. Regulating Outlets - The regulating outlets consist of a 12-inch cast iron suction line with sluice gate control connected to the City water pumphouse and a 6-inch cast iron cleanout or flushing line with sluice gate control for gravity release.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

Design data for this dam were supplied by the Macon Municipal Utilities Office and are included with this report in Appendix C. The plans were developed by Burns and McDonnell Engineering Company of Kansas City in 1927 with corrections added in April 1928.

2.2 CONSTRUCTION

No construction history was available. It was reported by Mr. Paul Jensen, General Superintendent of Macon Municipal Utilities that the spillway ogee crest was raised approximately two feet in 1964. It is not known when the concrete spillway channel was extended. No data were available covering the raising of the ogee crest or the extension of the concrete spillway channel.

2.3 OPERATION

Water is drawn from the reservoir through the 12-inch cast iron suction line as required to meet the demands for potable water by the City of Macon. The 6-inch cast iron line serves as a means of flushing the gate chamber of debris.

2.4 EVALUATION

- a. Availability. The data included in Appendix C were readily available from the Macon Municipal Utilities Office.
- b. Adequacy. The field surveys, visual observations, and available data are considered adequate to support the conclusions of this report. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.
- c. Validity. The data and analyses are considered valid and adequate.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

- a. General. A visual inspection of the Macon Lake Dam was made on October 8, 1980. Engineers from Hoskins-Western-Sonderregger, Inc., Lincoln, Nebraska, making the inspection were:

Rey S. Decker - Geotechnical
John F. Burch - Geotechnical
Garold G. Ulmer - Hydraulics and Hydrology
Gordon Jamison - Hydraulics and Hydrology

The owner was represented during the inspection by Mr. Paul E. Jensen, P.E., General Superintendent, Macon Municipal Utilities.

- b. Dam.

- (1) Geology and Soils (abutment and embankment). The embankment is found in the dissected loess-till landscape of northern Missouri. The bedrock is of the Pennsylvania System and the Marmaton group. The local soils and embankment materials are silty clays of loess and till origin. Borings made on the crest during the inspection indicate that the materials in the embankment are CL-CH. The soils in the valley are developed on the Marmaton bedrock. The primary structural features are the Macon-Sullivan trough and the College Mound-Bucklin anticline.

The embankment rests on Duck Creek alluvium and the incised till and loess mantle of the Marmaton group. The loess is less than 6 feet in thickness, and local soil development on the loess is the Halton and/or Marion soil. Gosport and Mandeville soils are locally present on the Marmaton bedrock in the valley below the impoundment. The infiltration rates on the local soils range from moderate to slow.

The Marmaton group consists of limestones, shales, clays and coal beds. Strip mining occurs nearby in this group. Dark gray, fissile shale is exposed in the right abutment in the spillway banks about 400 feet downstream from the spillway crest at about elevation 770. Solution cavitation is not recognized in this area, and sink hole collapse was not observed.

The Macon-Sullivan Trough trending N.W. - S.E. underlies this site, and the College Mound-Bucklin anticline is 10 miles away to the southwest. Both are gentle structural features.

Seismically this dam is located in Zone 1 with minor probability of damage. The only recorded earthquake centered in this region is the February 24, 1906 earthquake registering III on the Modified Mercalli scale.

- (2) Upstream Slope. The upstream slope is well riprapped with limestone, concrete and asphaltic concrete rubble. The riprap appears to be durable. It extends up to about 3.5 feet below the crest and has a nominal size of about 6 inches. The slope is well vegetated with adapted grasses above the riprap. A few small shrubs and trees are growing on the slope.

The upstream slope and riprap are shown in Photos 3, 7 and 31. Two small slump or eroded areas were noted on the slope between Stations 3+80 to 4+10 and around Station 5+20. These areas occur just above the riprap and have been stabilized with riprap and rubble. Photo 8 shows one of the slump or eroded areas. No other significant erosion was noted along the upstream slope. No cracks or deformations were observed on the slope. Measurements indicated that the slope is flatter than shown on the plans (1V on 2.4H vs 1V on 2.0H). The large oak tree shown in Photo No. 27 is rooted in the right abutment and should not be of concern.

- (3) Crest. The left end of the crest is well gravelled and serves as a roadway to the outlet works. The remainder of the crest is very well vegetated with adapted grasses. Measurements indicate that the profile of the crest is remarkably uniform with only one station below the planned elevation of 800 (Sta. 6+00 @ 799.9). No cracks or deformations were noted along the crest. Photos 4 and 12 show the crest.

- (4) Downstream Slope. The downstream slope is very well vegetated with adapted grasses. No cracks, deformations, rodent activities or seeps were observed on the slope or along the toe of the slope. Photos 5 and 12 show the downstream slope. The ornamental trees in the right abutment trough, shown in Photo 12, should not endanger the embankment. Mr. Jensen reported that a seep area appears intermittently about 70 feet downstream from the toe of the dam near Station 8+00. This seep has been observed ever since the dam was built and would appear to be located in the old natural drainageway. The seep area was dry to a depth of 2 feet below the surface at the time of inspection. Photo 28 shows the seepage area.

The plans show riprap on the downstream toe of the dam. This riprap was not evident during the inspection.

c. Appurtenant Structures.

- (1) Spillway. The spillway is located in the right abutment. It consists of a concrete ogee weir control section and concrete lined exit channel that extends about 480 feet ± downstream

from the weir. Three drop structures, located in the exit channel, accommodate about 30 feet of drop from the weir crest to the old channel. The plans show the concrete exit channel extending about 285 feet downstream from the weir (to the first drop structure). It is not known when the concrete spillway channel was extended.

The weir crest is 85 feet wide with the exit channel varying from 85 feet to 45 feet wide at the lowest drop.

The concrete wing walls and crest of the weir structure appear to be in good condition with one small crack observed in the left wing wall. Photos 11, 13 and 27 show the weir crest and wing walls. Some cracks and spalling were observed in the original weir structure which was capped with 2 feet of new concrete in 1964. Plate 16 shows a crack in the original structure.

The floor and side walls of the first (original) exit channel section are quite badly cracked and checked. Some cracks up to 3/4-inch in width and some holes in the floor up to 12-inches in diameter with eroded channels under the floor extending 4 to 5 feet or more were observed. Photos 14 and 16 show the first section of the exit channel with vegetation (mostly weeds) growing in the cracks. Photos 15, 17, 18, 19 and 20 show cracks and holes in the floor and side walls of the first section of the channel.

The concrete in the two sections downstream from the first (original) section is in better condition than that in the first section. Considerable surface scaling and some spalling in the joint cracks was observed. Photos 22, 24 and 26 show the lower two sections of the spillway channel.

Some cracking and deterioration was observed in the drop structures as shown in Photos 20, 21, 23 and 25.

Mr. Jensen reported that they keep the trees cut out of the spillway channel but do not worry about the weed growth. He also reported that they repair the major holes in the channel as they occur and that they would be working on the larger ones observed during the inspection.

Shale is exposed in the banks along the lower portion of the exit channel and in the bottom of the creek channel. No serious erosion was apparent in the stream channel.

According to the data shown in the plans (Appendix C), the entire spillway was cut through or into shale and/or sandstone bedrock. If this is true, structural failure of portions of the concrete channel should not result in rapid and uncontrollable breaching of the reservoir.

- (2) Outlet works. The outlet works consisting of a gate chamber and two cast-iron outlet pipes, as described in paragraph 1.2a(5) and as shown on the plans (Appendix C) appear to be in good condition and are operated regularly as needed by the city for water supply. Photos 4, 5 and 6 show portions of the outlet works.
- d. Reservoir Area. Most of the reservoir area is bounded by grass and trees. No significant erosion was noted around the reservoir nor were there indications of heavy siltation. Photo 9 shows a portion of the reservoir.
- e. Downstream Channel. The earthen channel downstream from the concrete spillway channel is open. It is bordered by several large trees and passes under Highway 36 in two 12' x 14' concrete box culverts. Shale and coal seams are exposed in the channel banks, and some seepage was emerging into the channel from these formations. Photos 22 and 24 show the downstream channel.

3.2 EVALUATION

The dam is well maintained and appears to be in excellent condition with no evident potential of structural failure. The intermittent seepage downstream from the toe of the dam has no apparent adverse effect on stability of the dam. It is felt that this seep results from seepage through the shale bedrock, as observed in the spillway outlet channel.

The concrete in the first section of the spillway channel (from the weir structure to the first downstream drop structure) is in poor condition with many sizable cracks and holes in the floor and side walls. Considerable repair work should be done on this section. Concrete in the lower two sections of the spillway channel is in fair condition with some minor scaling and spalling that do not appear to endanger the structural stability of the channel. Some repair work should be done on the drop structures, particularly the second drop located about 390 feet ± downstream from the weir.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

This is a city water supply reservoir. The maximum pool level is controlled by rainfall, infiltration, evaporation, and the capacity of the uncontrolled spillway. The ultimate pool level is controlled by the demands for city water. Mr. Jensen reported that the present pool level is about as low as it has ever been. He also reported that there has been as much as 2 feet of flow through the spillway but that there has not been flow through it this year.

4.2 MAINTENANCE OF DAM

Maintenance of the dam appears to be good with regular mowing and brush control. The only recent maintenance in the spillway appeared to be the removal of a few small trees. Considerable concrete repair work should be done in the spillway channel, particularly in the first section between the weir and the first downstream drop structure.

4.3 MAINTENANCE OF OPERATING FACILITIES

The operating facilities (water supply) appear to be well maintained.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

There is no warning system in effect for this dam.

4.5 EVALUATION

Maintenance of the dam is generally good. The few small shrubs and trees should be removed from the upstream slope. Although structural failure of the concrete spillway channel probably would not result in immediate breaching of the reservoir, it is recommended that major holes and cracks in the spillway floor, side walls and drop structures be repaired. Such repairs should minimize major repair or replacement work in the future that could result from erosion under the floor and side walls and uplift and displacement of the concrete lining.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

- a. Design Data. Detailed plans for this structure were furnished by the Macon Municipal Utilities Office, City of Macon, Missouri.
- b. Experience Data. The drainage area, reservoir surface area, and elevation-storage data were developed from the USGS Macon, Axtell, and Bevier North, Missouri 7 1/2 minute topographic quadrangle maps. The hydraulic computations for the spillway and dam overtopping discharge ratings were based on data collected in the field at the time of the field inspection. Hydrologic computations are included in this report as Appendix D.
- c. Visual Observations.
 - (1) The concrete crest of the ogee weir appears to be in excellent condition. The concrete wingwalls appear to be in fair condition with a few small cracks at the joints.
 - (2) The concrete in the exit channel floor and sidewalls shows considerable spalling and cracking. Some rehabilitation work should be done.
 - (3) Riprap on the upstream face of the dam is in good condition. It consists of some limestone (nominal size about 6 inches) and a considerable amount of concrete and asphaltic concrete rubble from street and building demolition. Riprap on the upstream slope extends to within about 3.5 feet of the top of the dam.
- d. Overtopping Potential. The spillway is too small to pass the probable maximum flood without overtopping the dam. The spillway will pass 55% of the probable maximum flood as well as the 1% probability flood without overtopping. Overtopping of the dam would be dangerous because the flow of the water over the crest could erode the downstream face of the dam and, if continued long enough, could breach the dam with sudden release of all of the impounded water onto the downstream floodplain.

The results of the routings through the dam are tabulated in regards to the following conditions:

<u>Frequency</u>	<u>Inflow Discharge c.f.s.</u>	<u>Outflow Discharge c.f.s.</u>	<u>Maximum Pool Elevation</u>	<u>Maximum Depth Over Dam Feet*</u>	<u>Duration Over Top Hours</u>
1%	3,270	1,930	795.5	-	-
1/2 PMF	8,050	5,640	799.3	-	-
PMF	16,100	15,300	801.7	1.8	7
D.55 PMF	8,900	6,350	799.9	-	-

*Minimum top of dam elevation - 799.9 ft

According to the recommended guidelines from the Department of the Army, Office of the Chief of Engineers, this dam is classified as having a high hazard potential and an intermediate size. Therefore, the probable maximum flood is the test for the adequacy of the dam and its spillway.

The estimated damage zone is described in Paragraph 1.2d in this report.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

- a. Visual Observation. The dam appears to be structurally stable. There is no evidence of cracks, slips, slides or deformations. The intermittent seep downstream from the toe of the dam does not appear to impair the structural stability of the dam.

Further deterioration of the concrete in portions of the spillway channel could lead to structural failure of the channel.

- b. Design and Construction Data. Design data were available from the City of Macon and are included in Appendix C of this report. The dam appears to have been constructed essentially as shown on the plans. The concrete spillway channel is about 192 feet longer than shown on the plans, and the spillway weir crest is 2 feet higher than shown due to raising the crest elevation in 1964. No construction data were available for the changes made after the initial construction.

Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dam" were not available, which is considered a deficiency.

- c. Operating Records. This reservoir supplies water for the City of Macon, and water is withdrawn as needed. Mr. Jensen reported that the present reservoir level is about as low as it has ever been. He also reported that as much as 2 feet of flow have passed through the spillway, but the spillway has not operated this year.
- d. Post Construction Changes. The spillway crest was raised 2 feet in 1964. It is not known when the concrete spillway channel was extended.
- e. Seismic Stability. This dam is located in Seismic Zone 1. An earthquake of the magnitude predicted in this area is not expected to cause structural failure of this dam.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

- a. Safety. The dam is in excellent condition and does not appear to have a serious potential of structural failure. According to the analyses performed for this dam, the spillway will pass 55 percent of the probable maximum flood without overtopping the dam. The probable maximum flood will overtop the dam by about 1.8 feet for a period of about 7 hours. Overtopping of the dam would be dangerous because the flow of water over the crest could erode the downstream face of the dam and, if continued long enough, could breach the dam with sudden release of all of the impounded water onto the downstream floodplain.

The deficiencies observed during the inspection (a few small trees and shrubs on the upstream slope and concrete deterioration in the spillway channel) do not appear to be serious at the present time. The small trees and shrubs should be removed, and repairs should be made in the spillway channel in the near future to forestall major damage, particularly in the upper section of the spillway.

Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

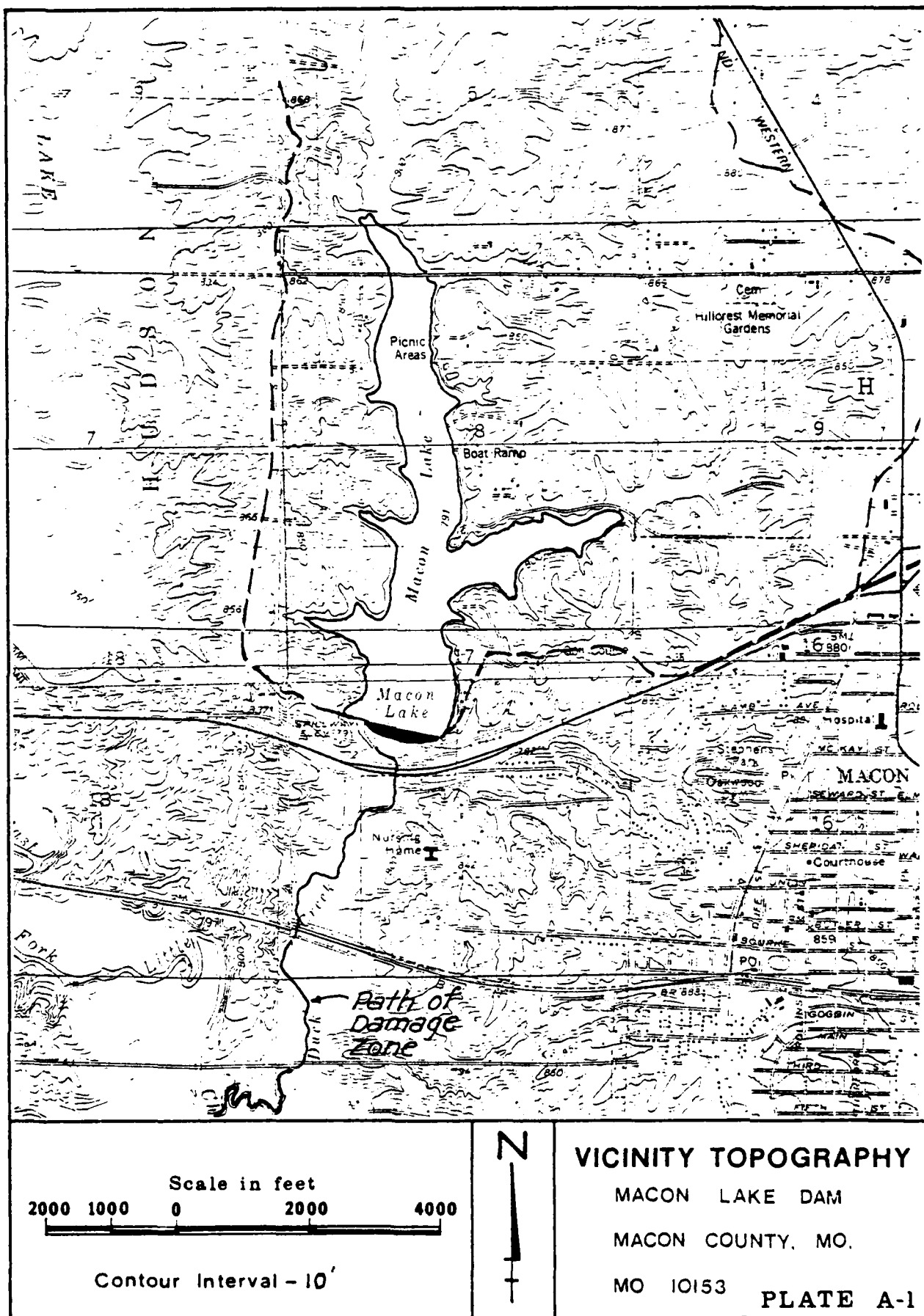
- b. Adequacy of Information. The available design data and information collected during the inspection are considered adequate to justify the conclusions presented in this report. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.
- c. Urgency. The remedial measures recommended in paragraph 7.2 should be accomplished in the near future. The item recommended in paragraph 7.2a. should be pursued on a high priority basis.
- d. Necessity for Further Investigations. The seepage and stability analyses recommended in paragraph 7.2b should be accomplished by the owner in the near future.
- e. Seismic Stability. This dam is located in Seismic Zone 1. An earthquake of this magnitude is not expected to be hazardous to this dam. It is recommended, however, that the prescribed seismic loading for Seismic Zone 1 be applied in any stability analyses performed for this dam.

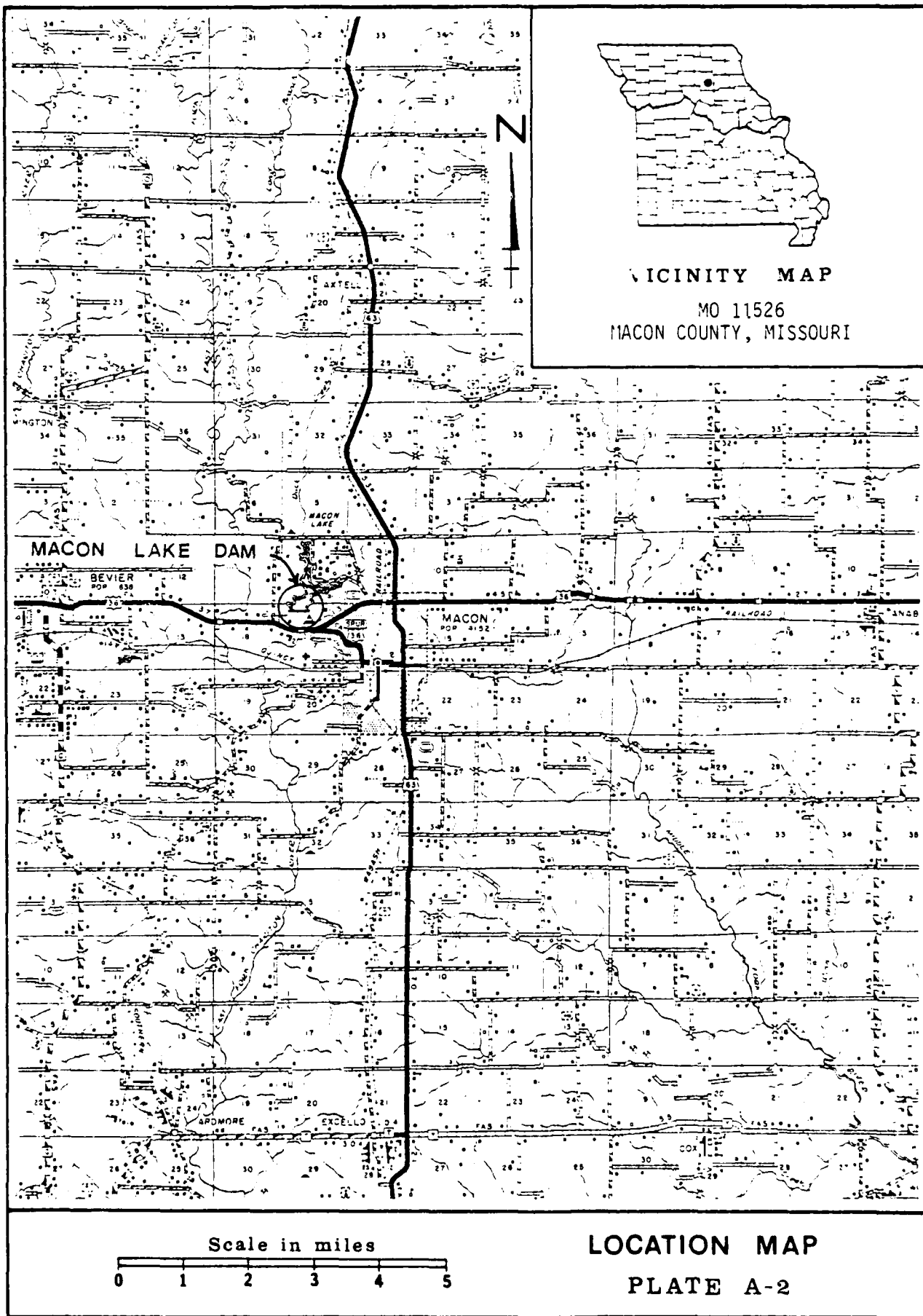
7.2 REMEDIAL MEASURES

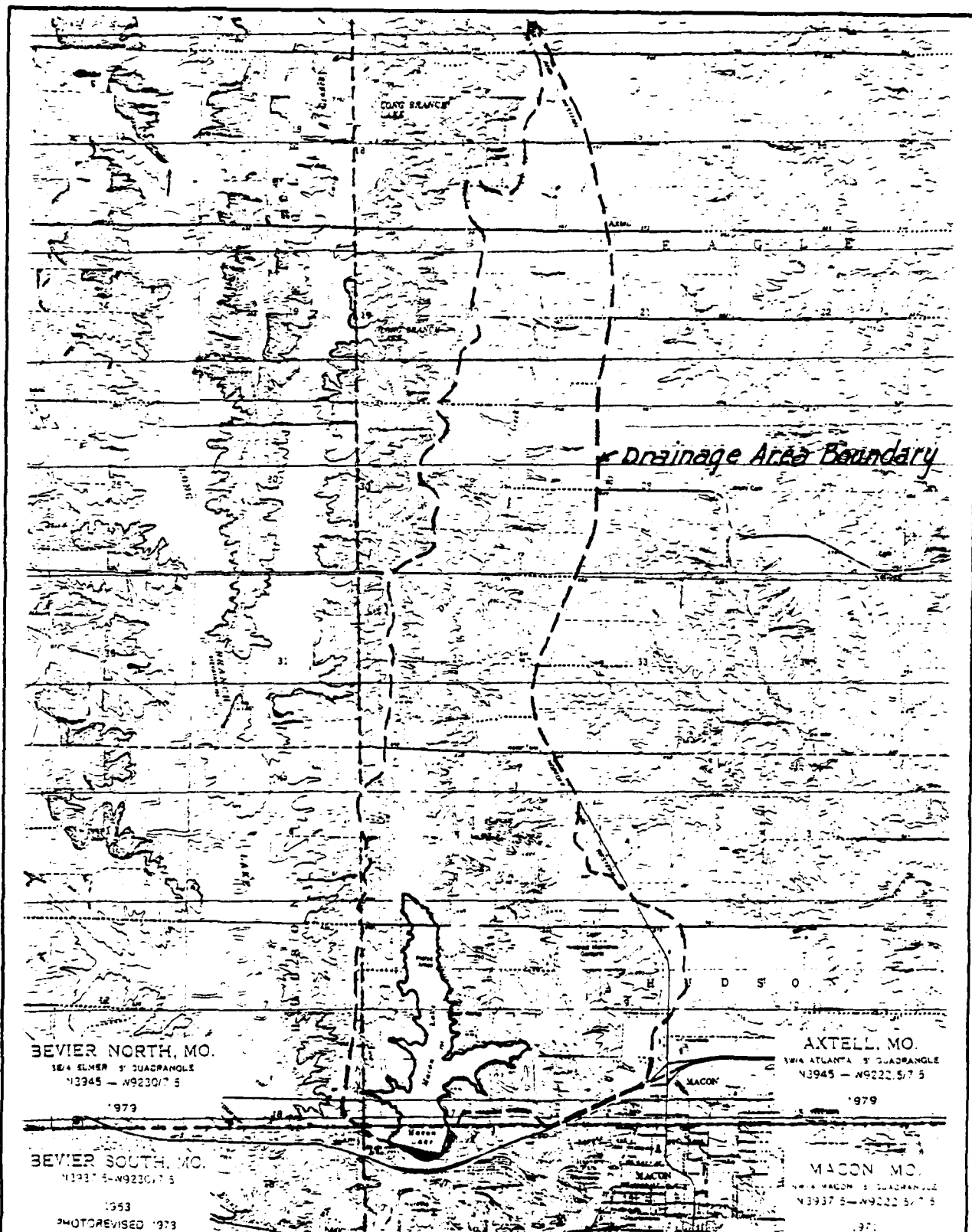
The following remedial measures and maintenance procedures are recommended. All remedial measures should be performed under the guidance of a registered professional engineer experienced in the design and construction of earth dams.

- a. Alternatives. The height of the dam should be increased and/or the spillway size and shape should be changed to pass the probable maximum flood without overtopping the dam.
- b. Operation and Maintenance Procedures.
 - (1) Seepage and stability analyses comparable to the requirements of the recommended guidelines should be performed by an engineer experienced in the design and construction of dams.
 - (2) The major cracks and holes in the concrete spillway channel and drop structures should be repaired.
 - (3) The small trees (saplings) and shrubs growing on the upstream slope should be removed and measures taken to prevent their recurrence.
 - (4) A program of periodic inspection and maintenance, with particular attention to the spillway, should be initiated and the inspection records made a part of this project file.

APPENDIX A
MAPS







MACON LAKE DAM
 MACON COUNTY, MO.
 MO 10153

DRAINAGE AREA MAP
 PLATE A-3

APPENDIX B
PHOTOGRAPHS



MACON LAKE DAM
MACON COUNTY, MISSOURI
MO 10153

PHOTO INDEX

PLATE B-1



PHOTO NO. 2 - OVERVIEW FROM LEFT UPSTREAM BANK



PHOTO NO. 3 - UPSTREAM FACE FROM LEFT END



PHOTO NO. 6 - CITY WATER SUPPLY INTAKE TOWER FROM CREST



PHOTO NO. 7 - UPSTREAM FACE TAKEN FROM INTAKE TOWER



PHOTO NO. 8 - SLUMP AREA
IN
UPSTREAM
FACE



PHOTO NO. 9 - LOOKING UPSTREAM FROM STATION 6+00



PHOTO NO. 10 - LOOKING DOWNSTREAM FROM STATION 7+00



PHOTO NO. 11 - LOOKING ACROSS OGEE SPILLWAY CREST FROM
LEFT TO RIGHT



PHOTO NO. 12 - CREST AND DOWNSTREAM SLOPE FROM RIGHT END



PHOTO NO. 13 - CRACK IN LEFT
ABUTMENT
WALL JUST
ABOVE SPILL-
WAY CREST

FORM 13 BACK



PHOTO NO. 14 - LOOKING DOWNSTREAM IN SPILLWAY EXIT CHANNEL
FROM CREST



PHOTO NO. 15 - HOLE SPALLED OUT OF SPILLWAY FLOOR,
APPROXIMATELY 4 FEET ACROSS, 4 INCHES
DEEP, AND ABOUT 70 FEET BELOW WEIR

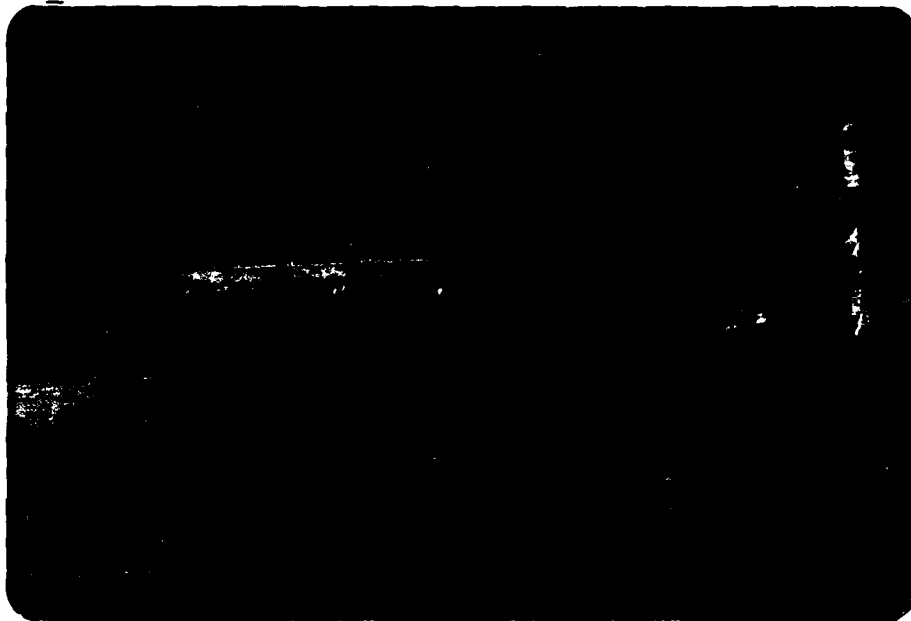


PHOTO NO. 16 - LOOKING UPSTREAM AT WEIR



PHOTO NO. 17 - ANOTHER CRACK IN FLOOR OF SPILLWAY

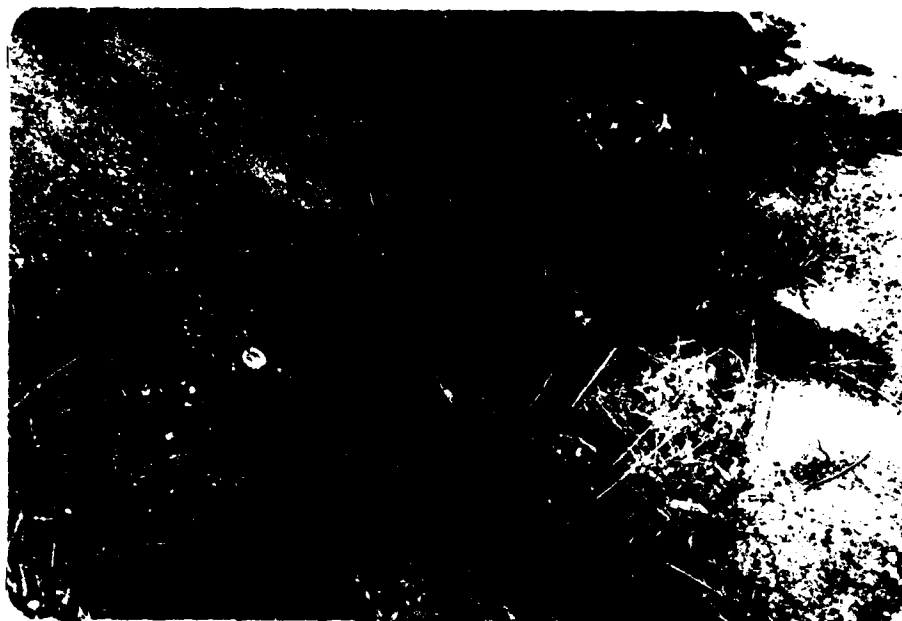


PHOTO NO. 18 - CRACKS SPALLING IN THE RIGHT WINGWALL OF
THE SPILLWAY CHANNEL

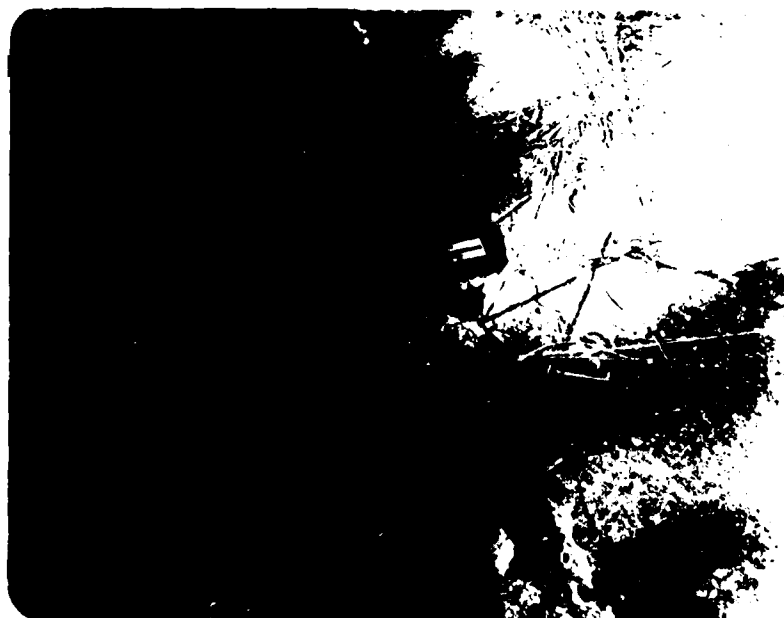


PHOTO NO. 19 - HOLE IN FLOOR OF SPILLWAY, 130 FEET DOWNSTREAM
FROM WEIR AND 10 FEET IN FROM RIGHT SIDE



PHOTO NO. 20 - LOOKING RIGHT TO LEFT ACROSS FIRST DROP IN
SPILLWAY CHUTE



PHOTO NO. 21 - CRACK IN RIGHT WINGWALL OF THE FIRST DROP
STRUCTURE



PHOTO NO. 22 - LOOKING DOWNSTREAM OVER TOP OF FIRST DROP
IN SPILLWAY CHUTE



PHOTO NO. 23 - LOOKING RIGHT TO LEFT ACROSS SECOND DROP
IN SPILLWAY CHUTE



PHOTO NO. 24 - LOOKING DOWNSTREAM FROM SECOND DROP IN
SPILLWAY CHUTE



PHOTO NO. 25 - LOOKING UPSTREAM AT SECOND DROP IN SPILLWAY
CHUTE



PHOTO NO. 26 - LOOKING RIGHT TO LEFT ACROSS SPILLWAY
CHUTE BELOW SECOND DROP STRUCTURE



PHOTO NO. 27 - OGEE SPILLWAY CREST FROM RIGHT END



PHOTO NO. 28 - SEEPAGE (WET) SPOT DOWNSTREAM FROM STATION
8+00

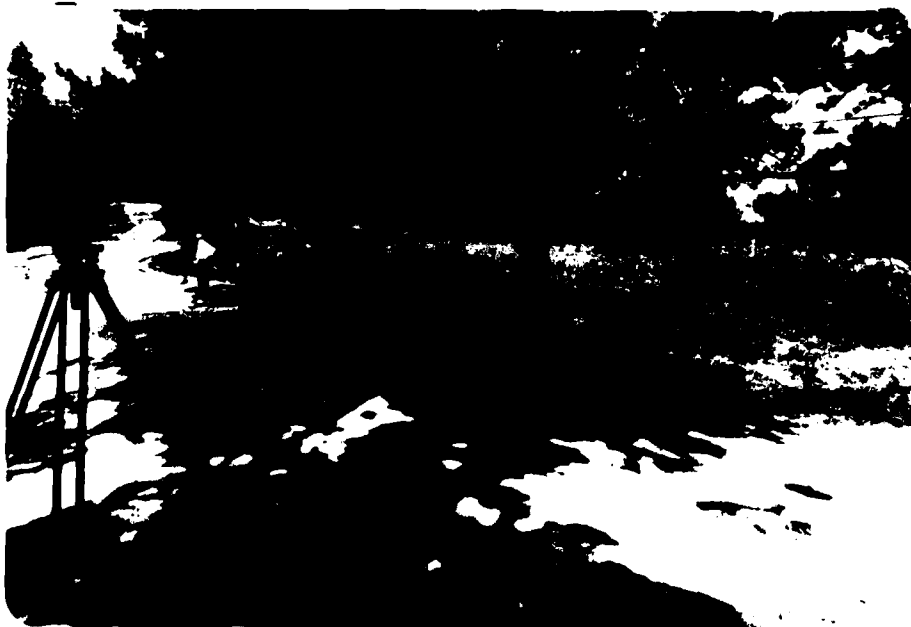


PHOTO NO. 29 - LOOKING ACROSS ROADWAY AT LEFT END OF DAM

GROUP 1

FORM 2



PHOTO NO. 30 - LOOKING DOWN THE ROADWAY AT LEFT END
OF DAM



PHOTO NO. 31 - CLOSE-UP
VIEW OF
RIPRAP
ON
UPSTREAM
SLOPE
NEAR
LEFT END
OF DAM

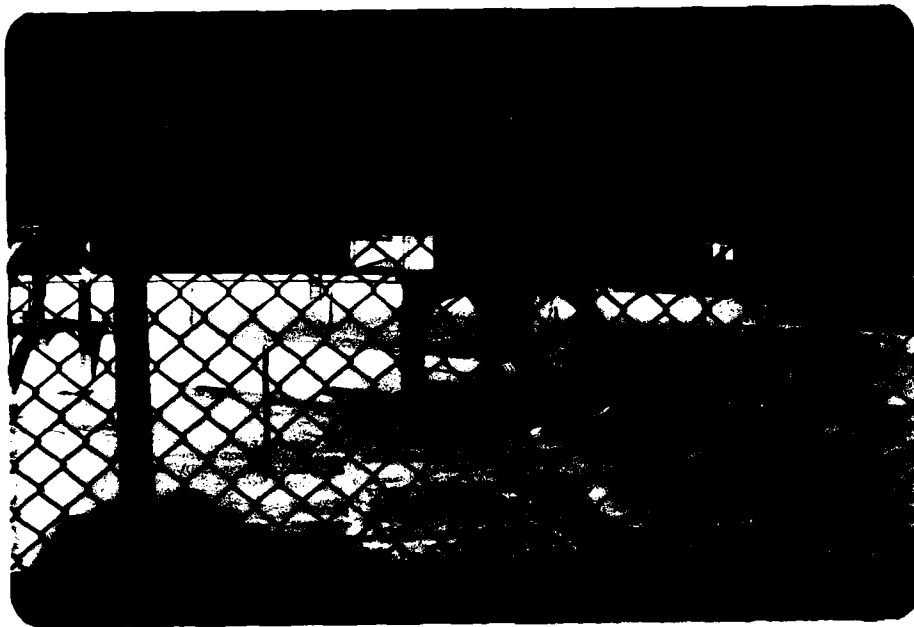


PHOTO NO. 32 - POOL AND WATERWORKS JUST BELOW THE DAM



PHOTO NO. 33 - DOWNSTREAM HAZARD FOUR (4) HOUSES JUST EAST
OF THE WATER PLANT

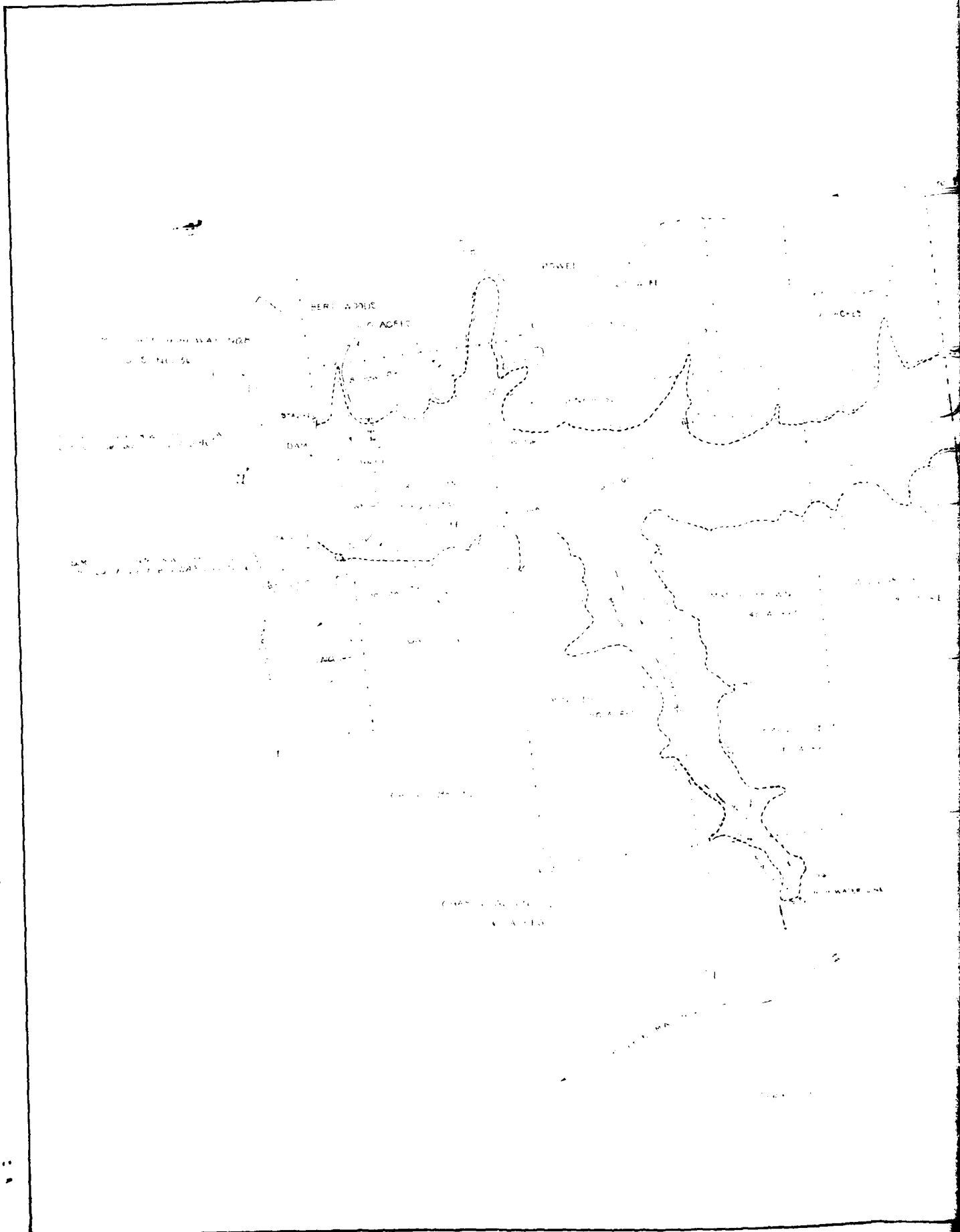


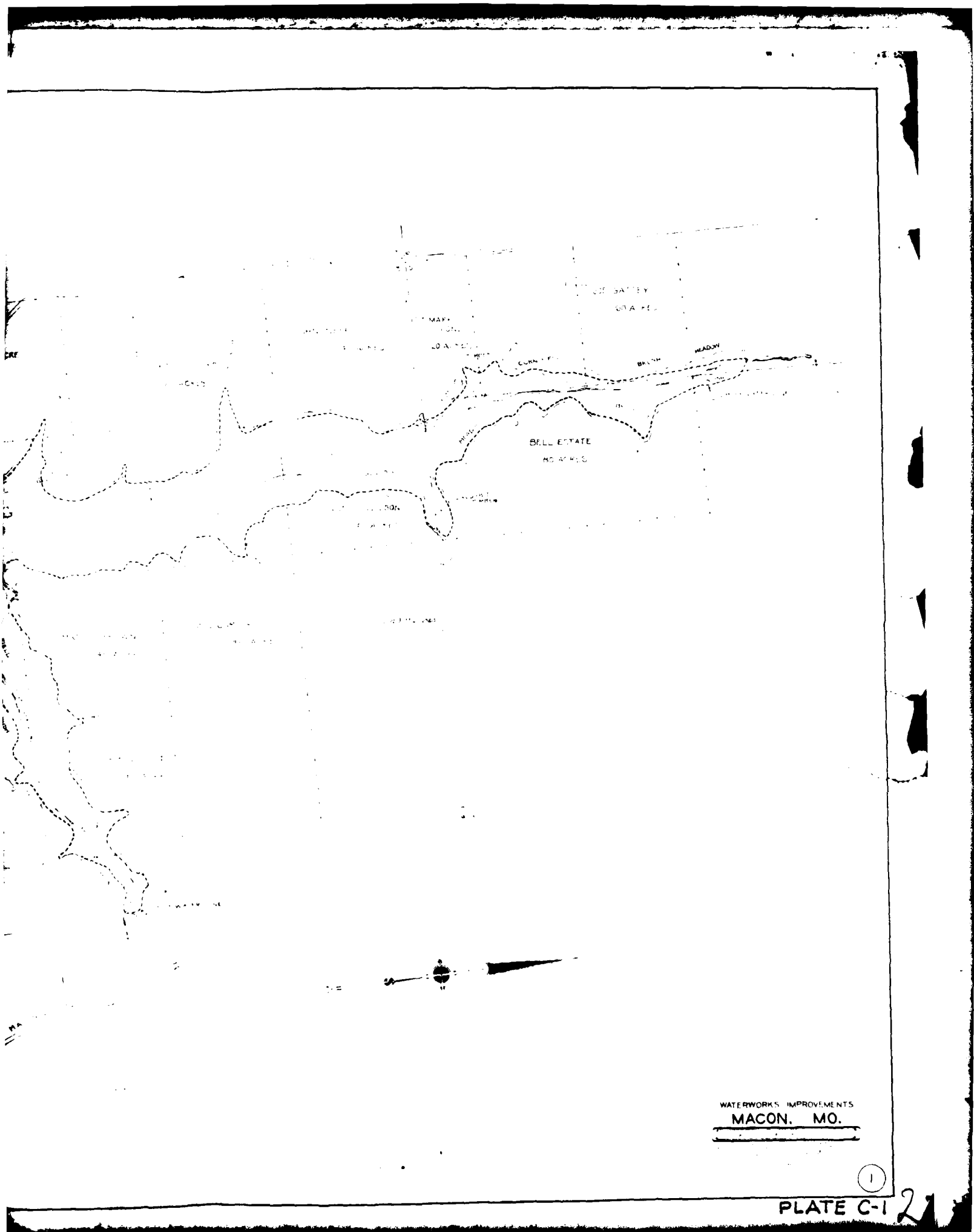
PHOTO NO. 34 - DOWNSTREAM HAZARD, JUST SOUTH OF HIGHWAY
AND ON RIGHT BANK



PHOTO NO. 35 - ANOTHER VIEW OF HOUSE JUST SOUTH OF HIGHWAY
AND ON RIGHT BANK

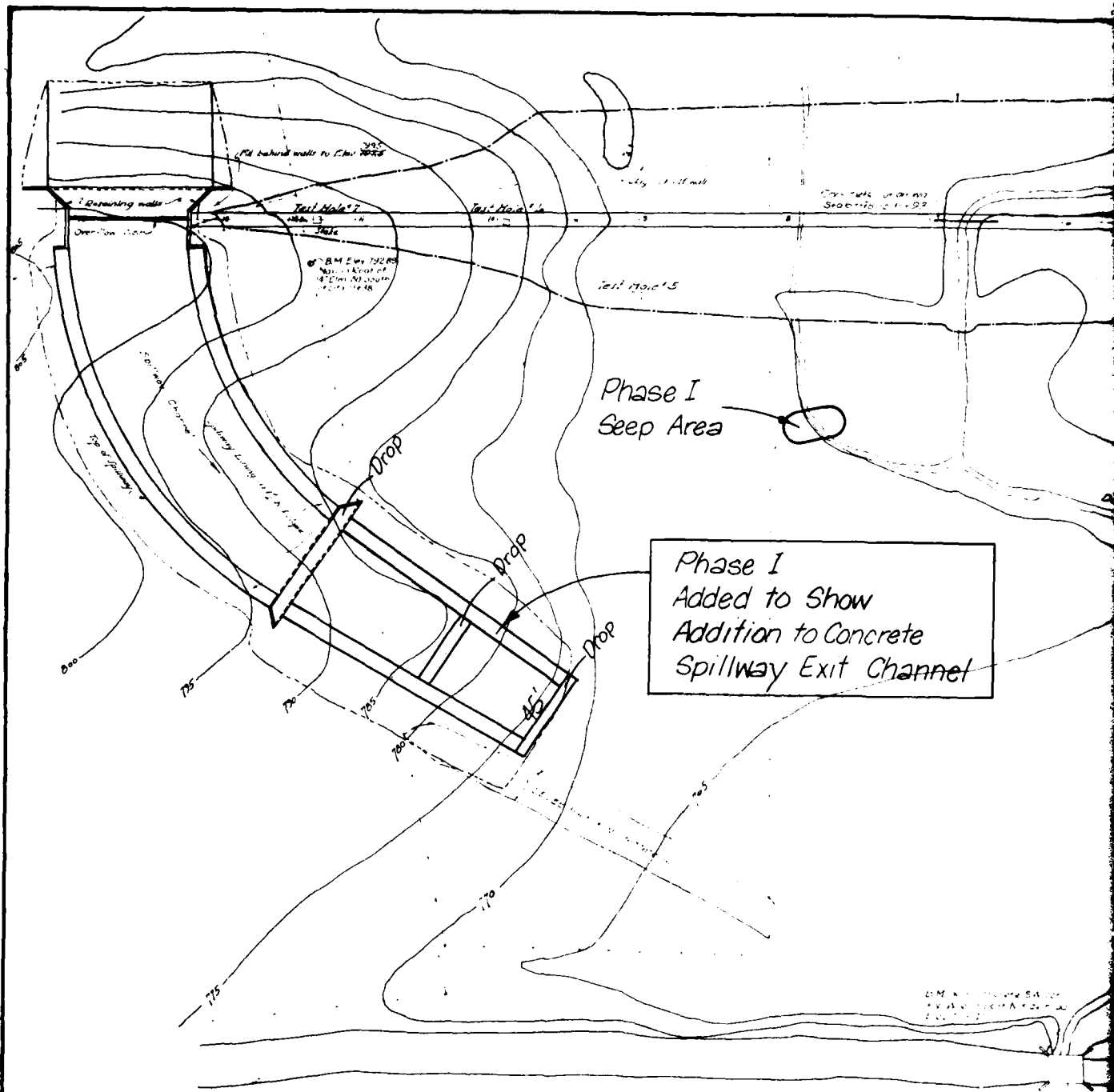
APPENDIX C
PROJECT PLATES





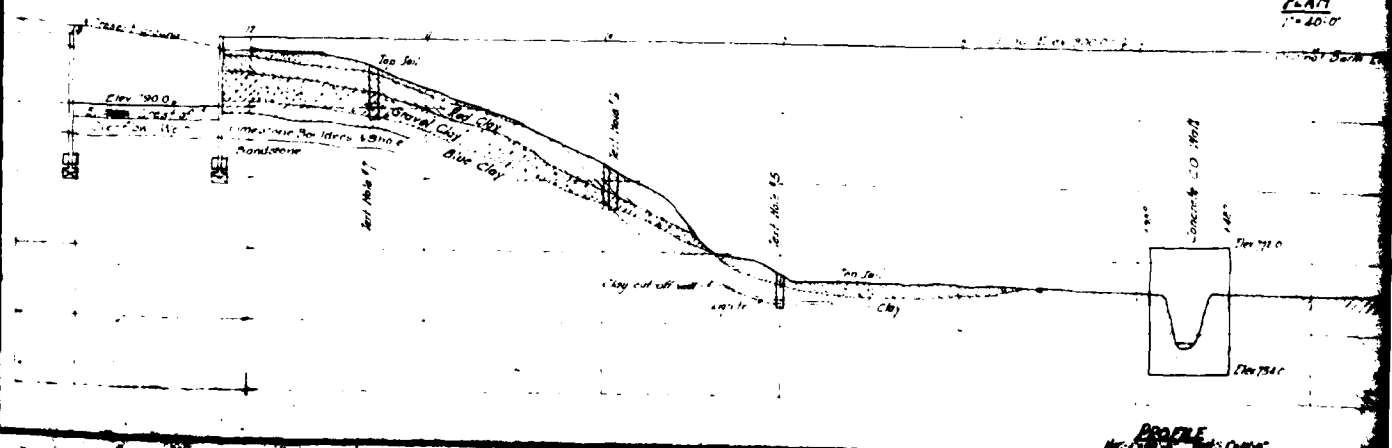
WATERWORKS IMPROVEMENTS
MACON, MO.

1



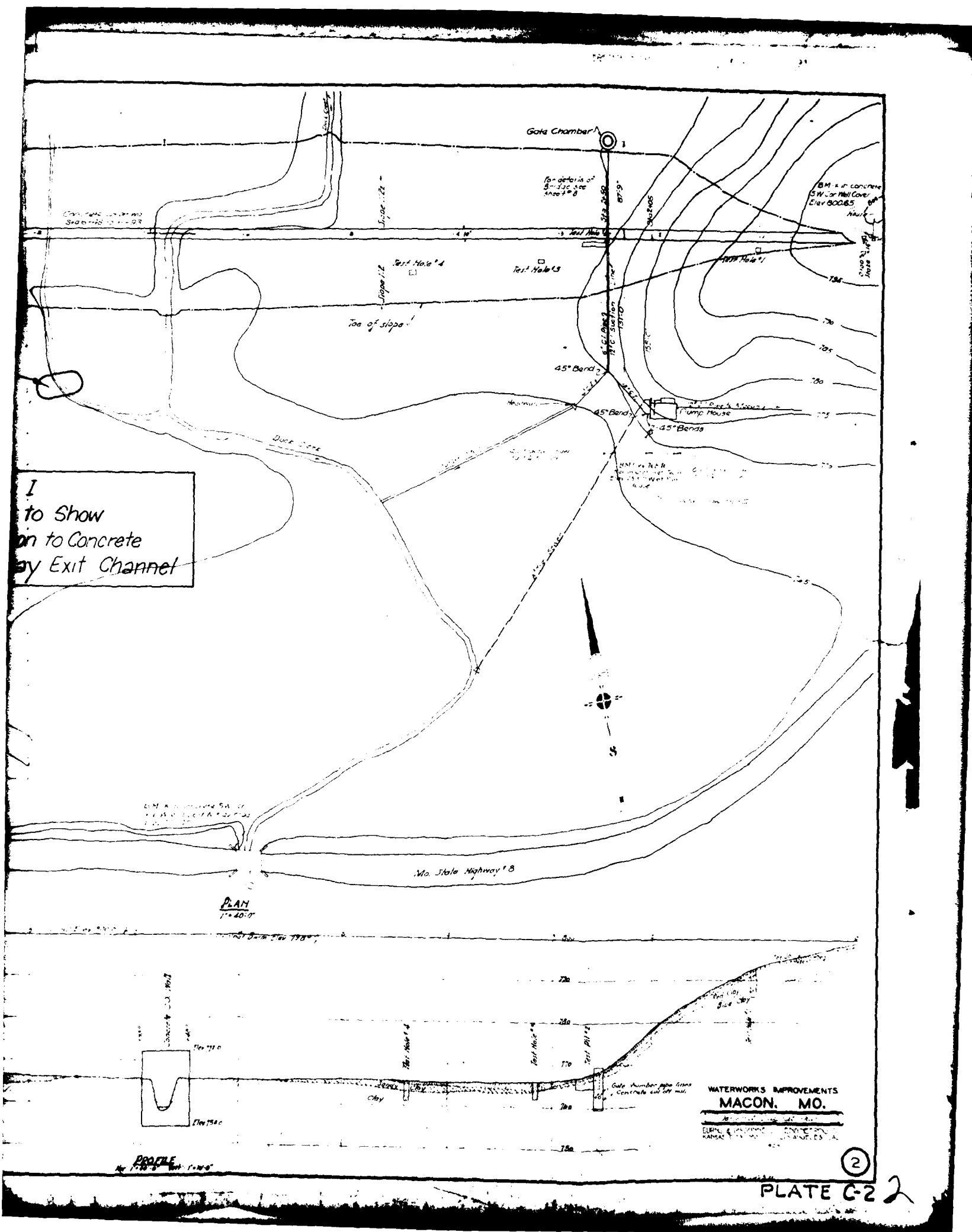
Phase I
Seep Area

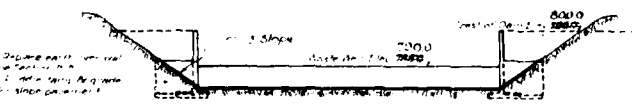
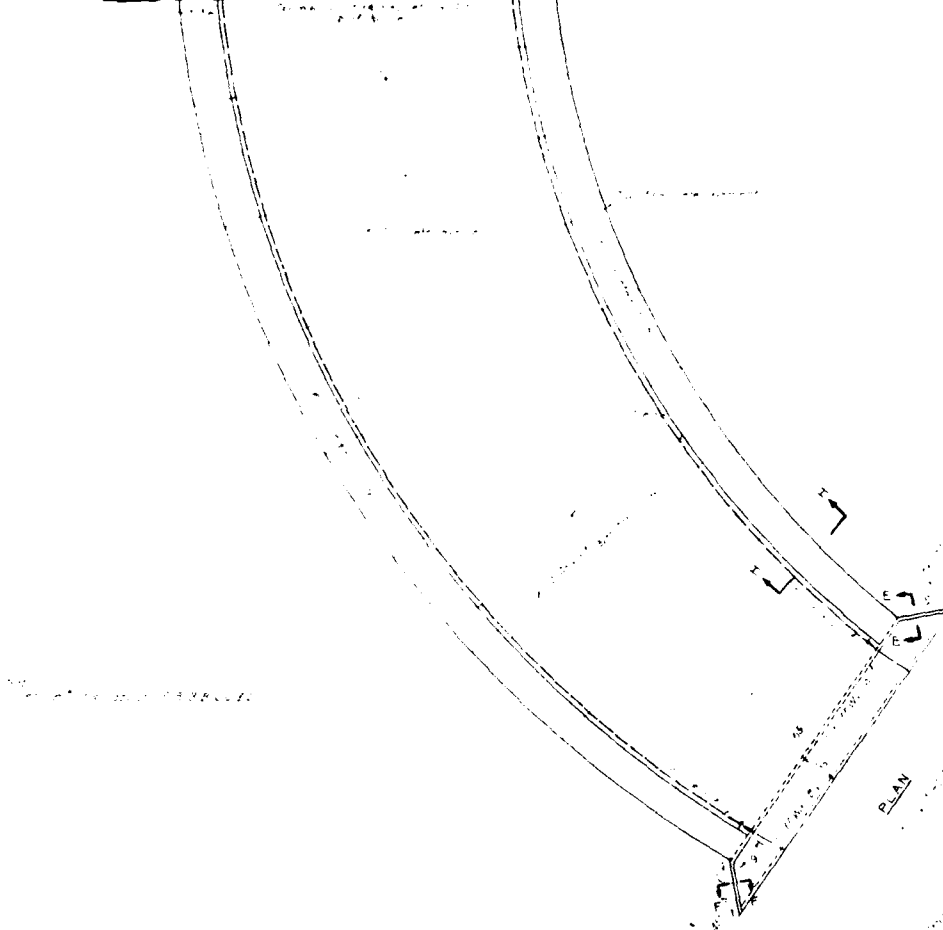
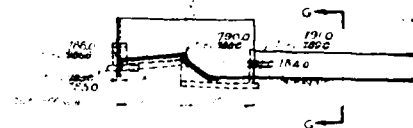
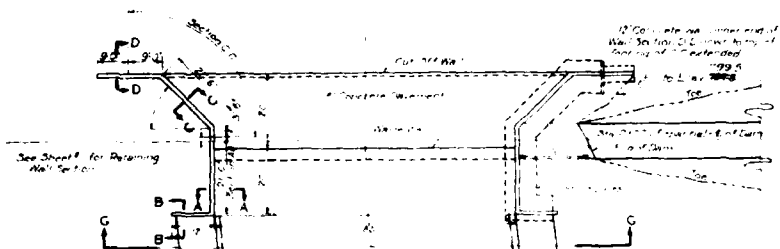
Phase I
Added to Show
Addition to Concrete
Spillway Exit Channel



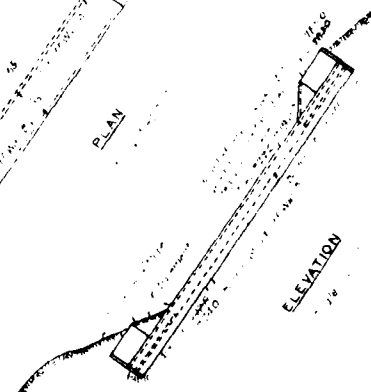
PLAN
1"=40' 0"

PROFILE
1"=40' 0"





SECTION G-G



ELEVATION



SECTION H-H

Note: Dimensions are given in feet
unless otherwise noted.

Sta 0+00 Elevation 100

Const Elev 800.0

Elev 799

Sta 0+20

Elev 800.0

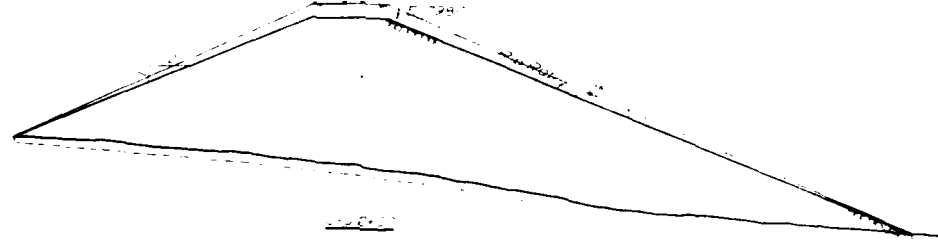


Sta 0+40

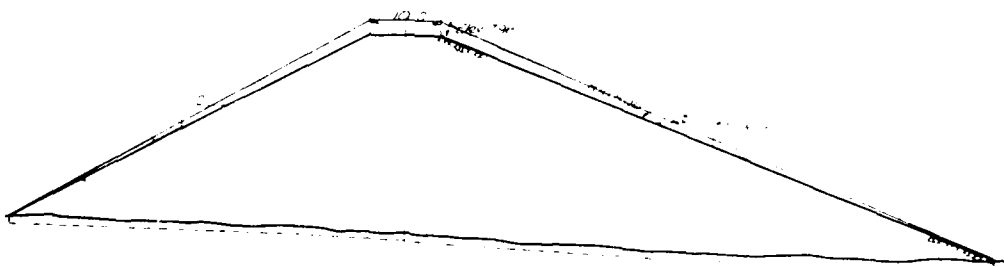
Elev 800.0



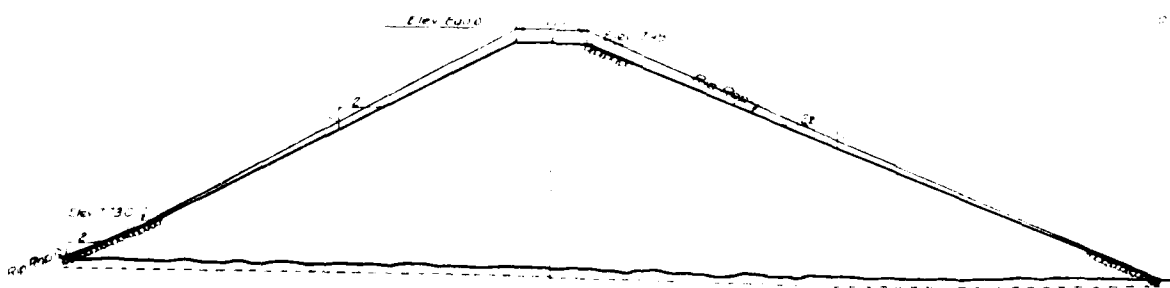
Sta 0+60



Sta 0+80



Sta 0+80



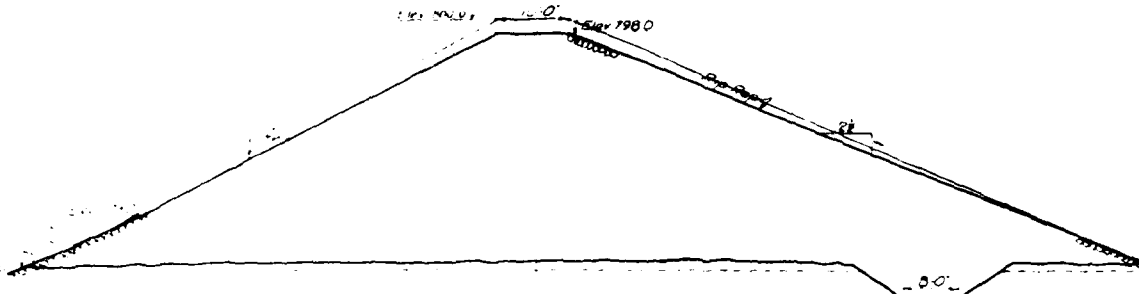
Sta 0+00

Scale 1" = 10'-0"

NOT TO SCALE

1.5% SLOPE

ELEV 798.0



CHAS. CUT 34' WIDE
SP. 8' x 5' 40' SLO 10:100

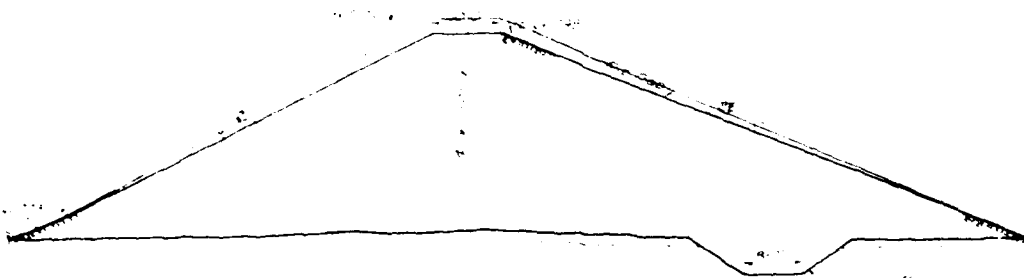
2.5% SLOPE



3.5% SLOPE



4.5% SLOPE



5.5% SLOPE

Note:
The above section is for
reference only and should
not be used for construction.

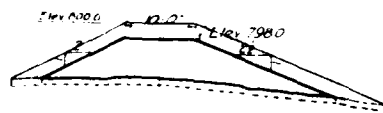
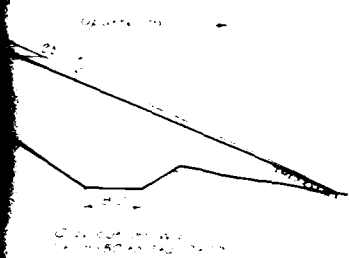
Scale 1" = 10'

WATERWORKS IMPROVEMENTS
MACON, MO.

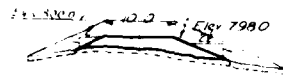
RETO & SMOOTHER
RATON, MO.

4

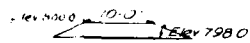
PLATE C-4



Sta 11+00

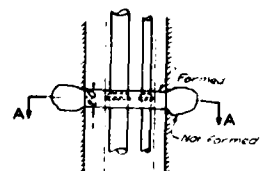


Sta 11+20



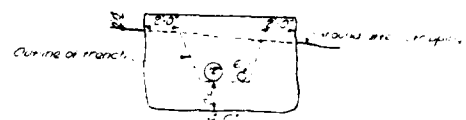
Sta 12+00 End of Fill

SECTIONS THROUGH DAM
Scale 1" = 5' 0"



PLAN

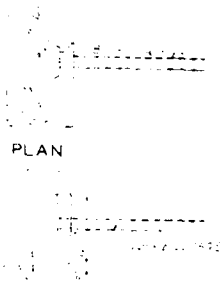
Scale 1" = 10'



SECTION A-A

Scale 1" = 10'

DETAILS OF CUT-OFF WALLS ON OUTLET PIPES



PLAN

SECTION

DETAILS OF BULKHEAD ON SEWER LINE
Scale 1" = 5' 0"

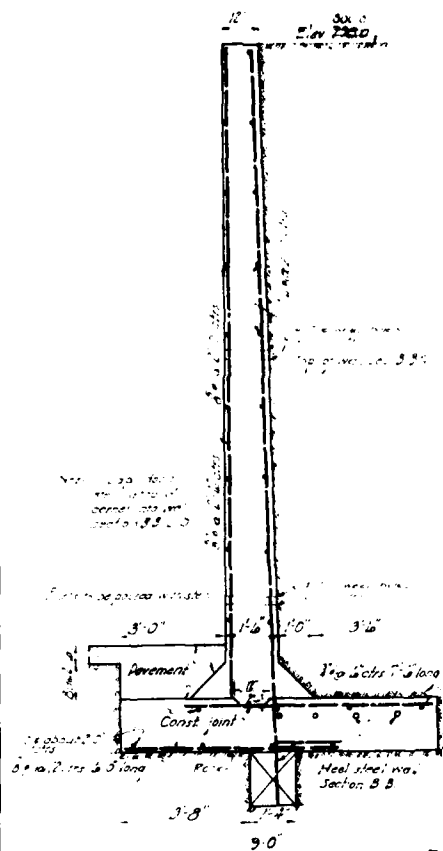
PROFILE OF SEWER

Station 11+00 to 12+00
Elev 798.0 to 799.0

SECTION AT STA 2+50
Scale 1" = 5' 0"

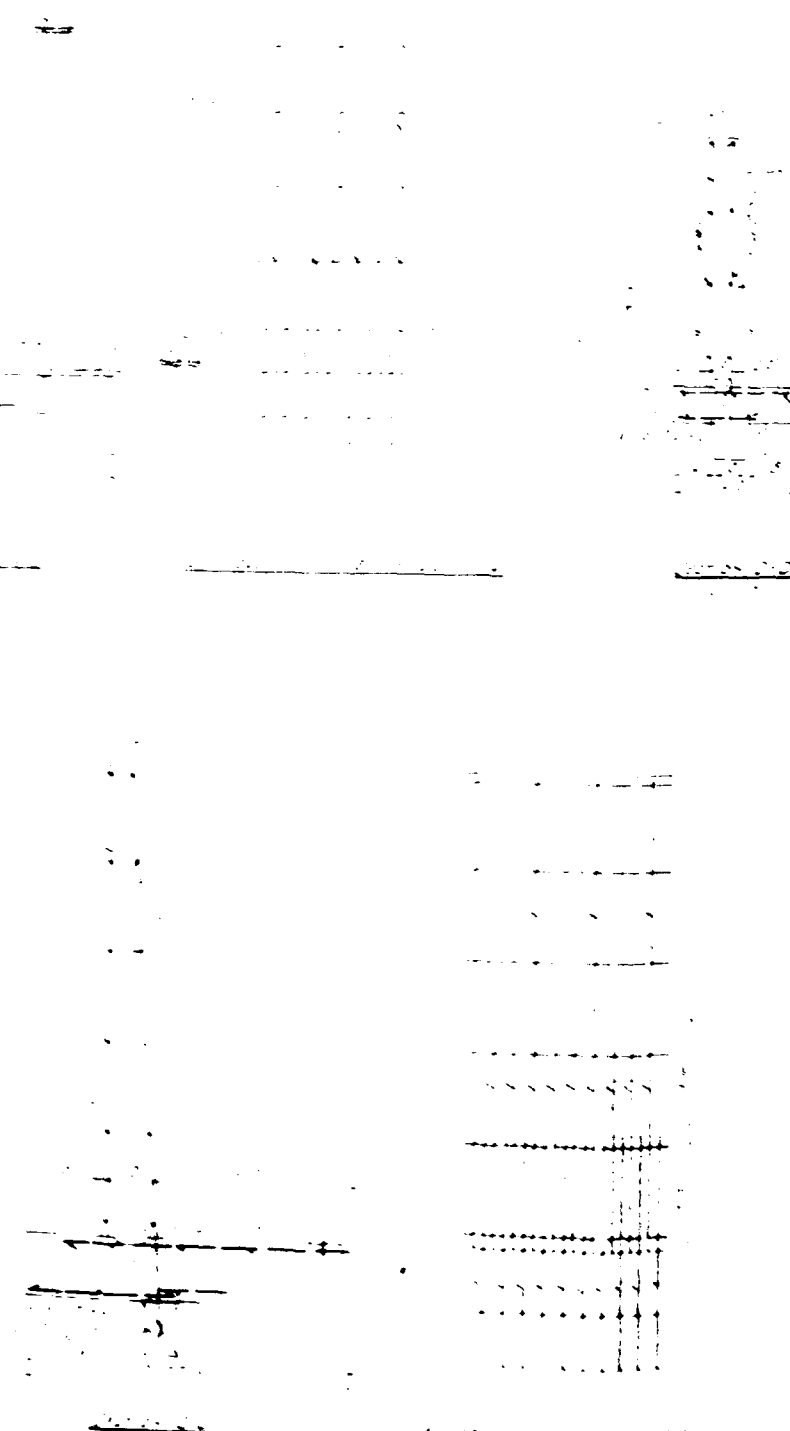
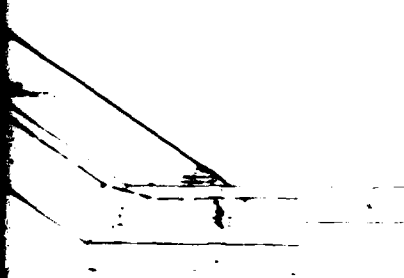
WATERWORKS IMPROVEMENTS
MACON, MO.

PLUMBS & MULLIN
MAISON CITY, MO.



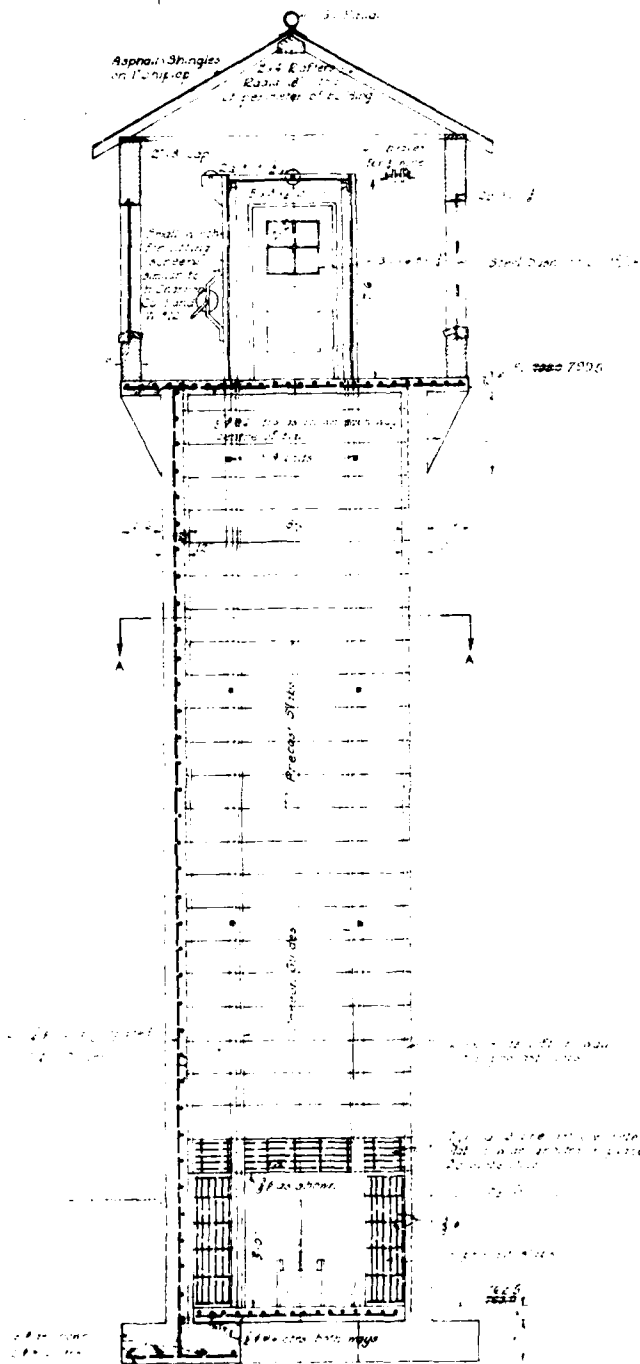
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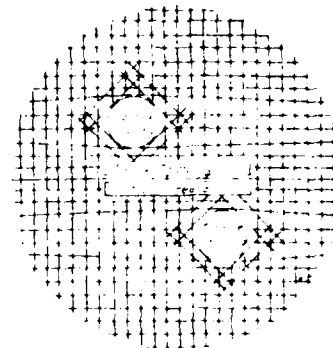
WATERWORKS IMPROVEMENTS
MACON, MO.

6

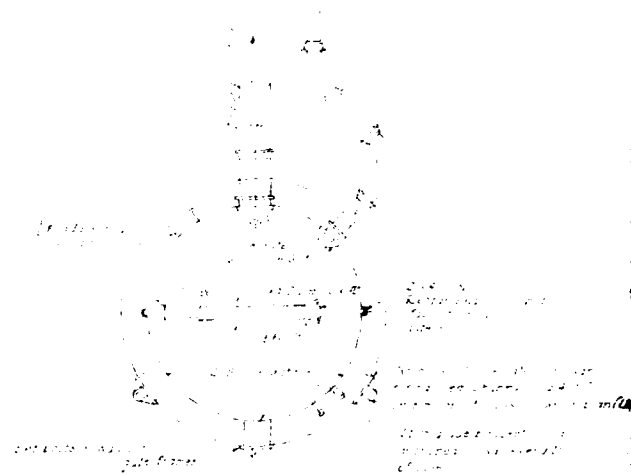


SECTION THRU GATE CHAMBER

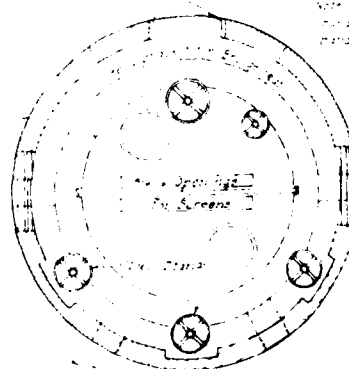
Scale 1/8\"/>



PLAN - OPERATING FLOOR
SHOWING REINFORCING STEEL

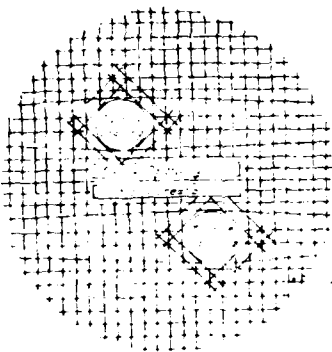


SECTION A-A



OPERATING FLOOR

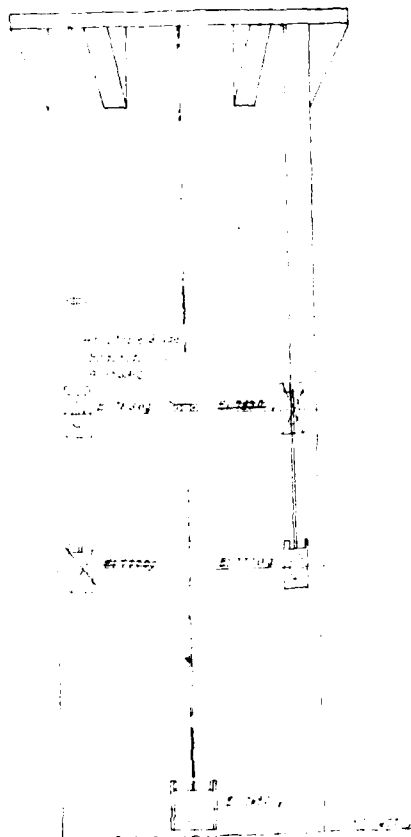
Scale 1/8\"/>



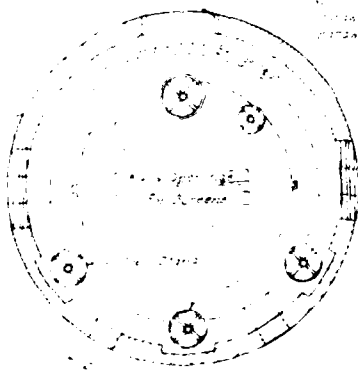
PLAN - OPERATING FLOOR
SHOWING REINFORCING STEEL



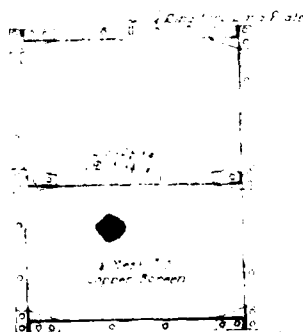
SECTION A-A



ELEVATION - GATE CHAMBER
SHOWING INLET GATES



OPERATING FLOOR



SCREEN DETAIL

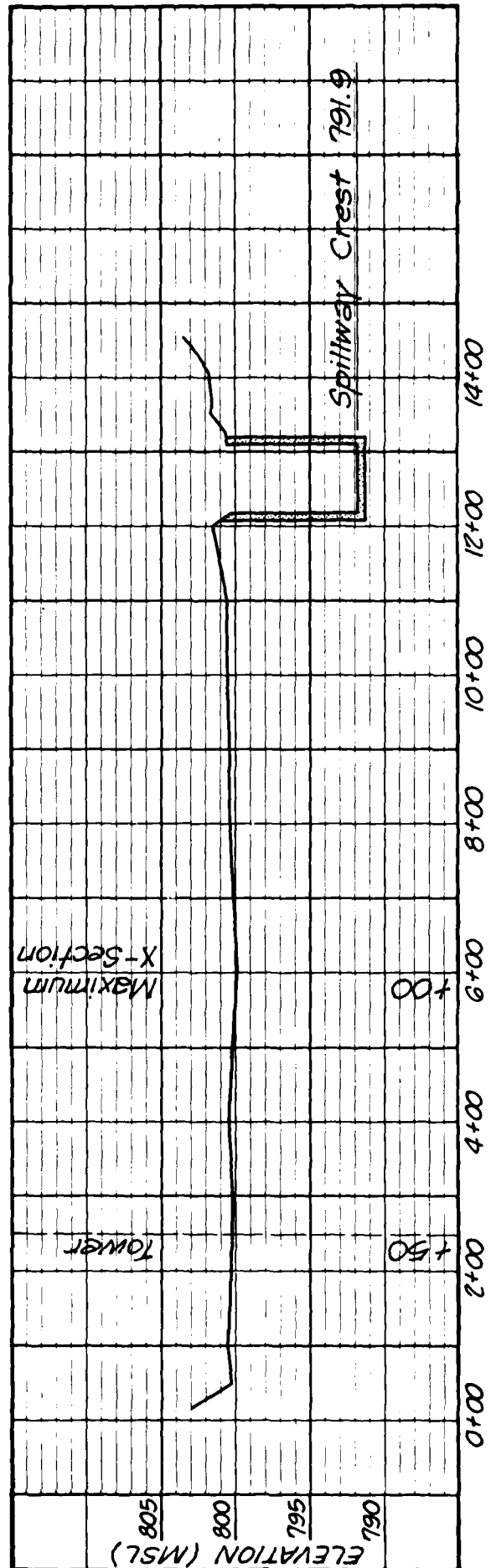
Scale 1/2"

WATERWORKS IMPROVEMENTS
MACON, MO.

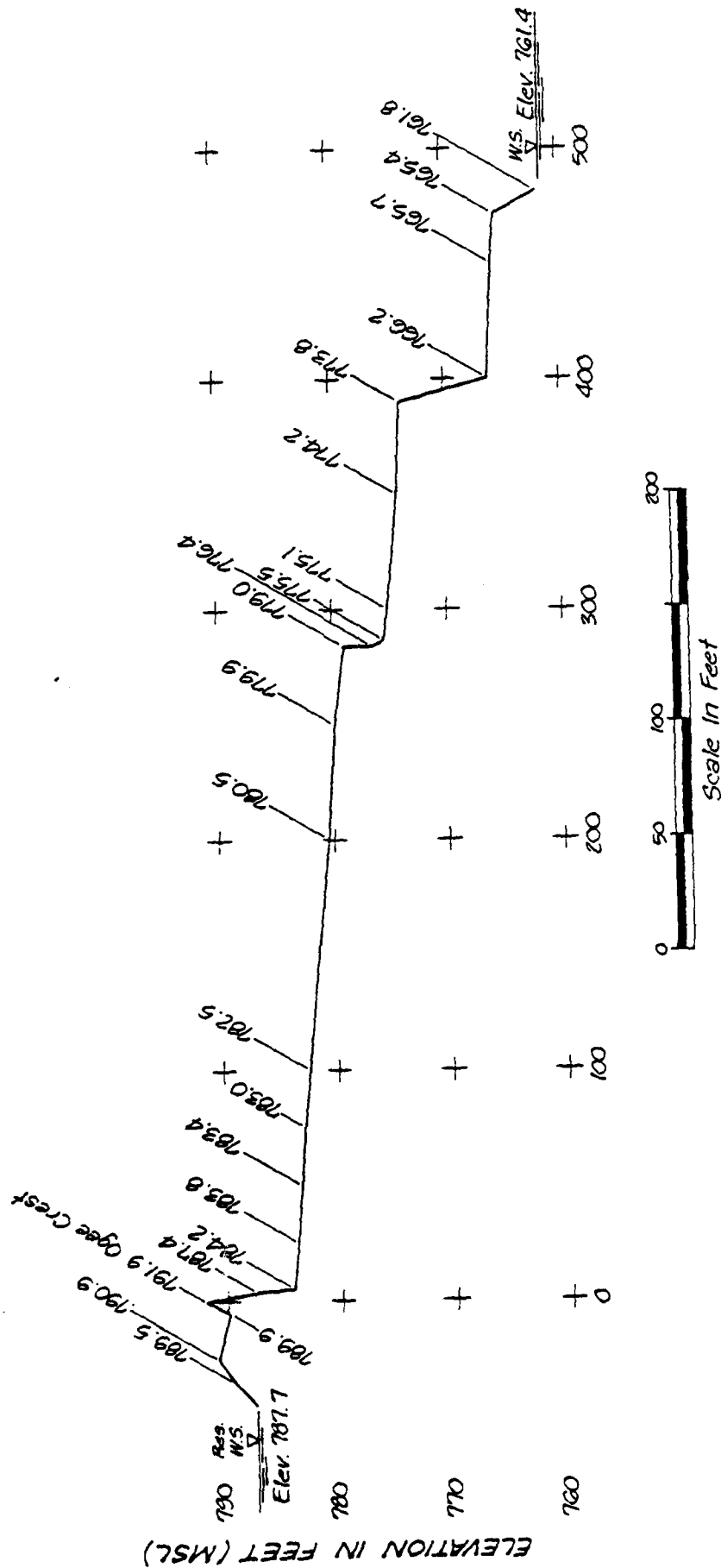
DESIGNED BY: [illegible]
DRAWN BY: [illegible]
CHECKED BY: [illegible]
APPROVED BY: [illegible]



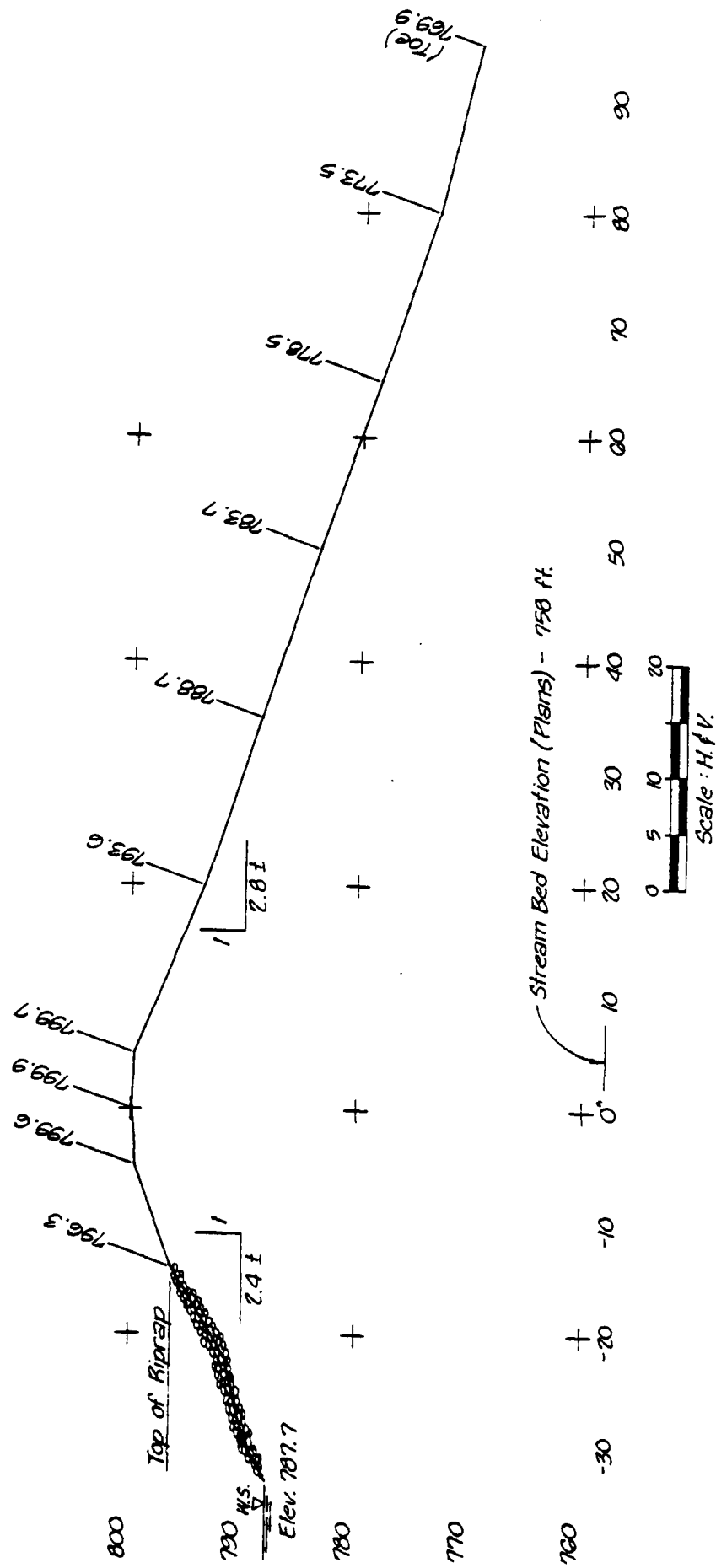
PLAN OF DAM
Scale: 1" = 200'



CENTERLINE PROFILE OF DAM
Scale As Shown



PROFILE ALONG CENTERLINE OF SPILLWAY AND EXIT CHUTE



MAXIMUM CROSS-SECTION OF DAM AT STA. 6+00

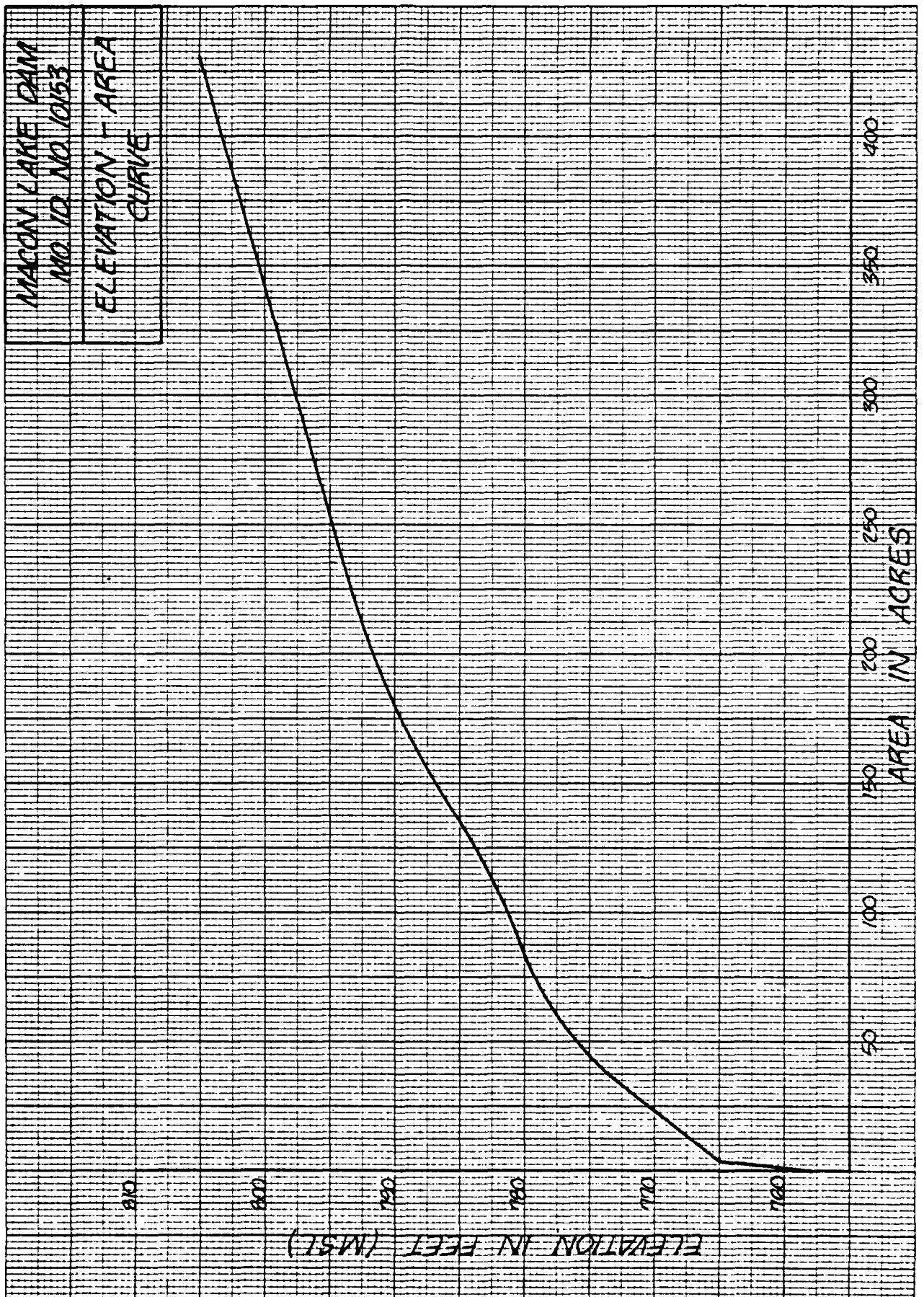
APPENDIX D
HYDRAULIC AND HYDROLOGIC DATA

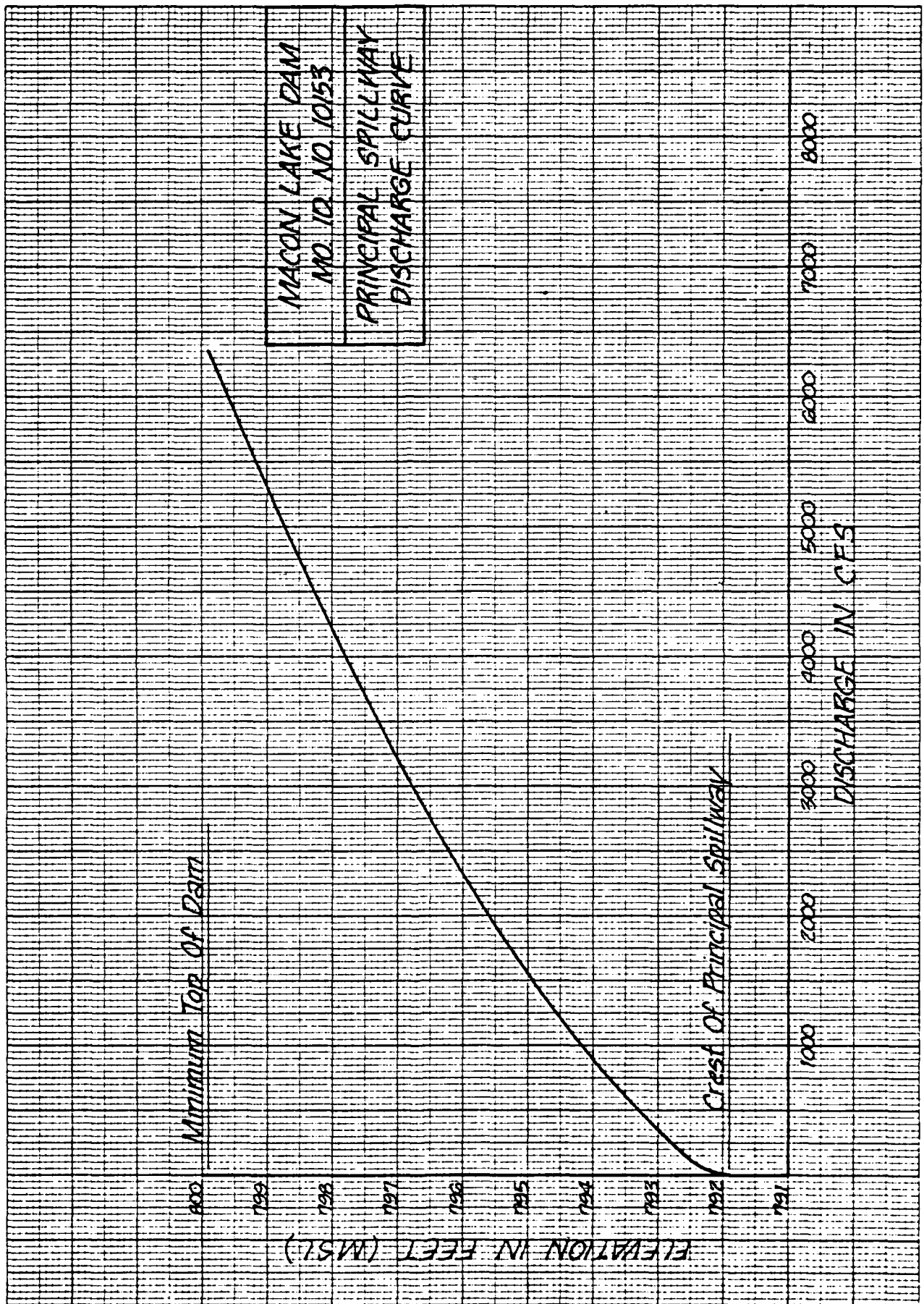
HYDROLOGIC COMPUTATIONS

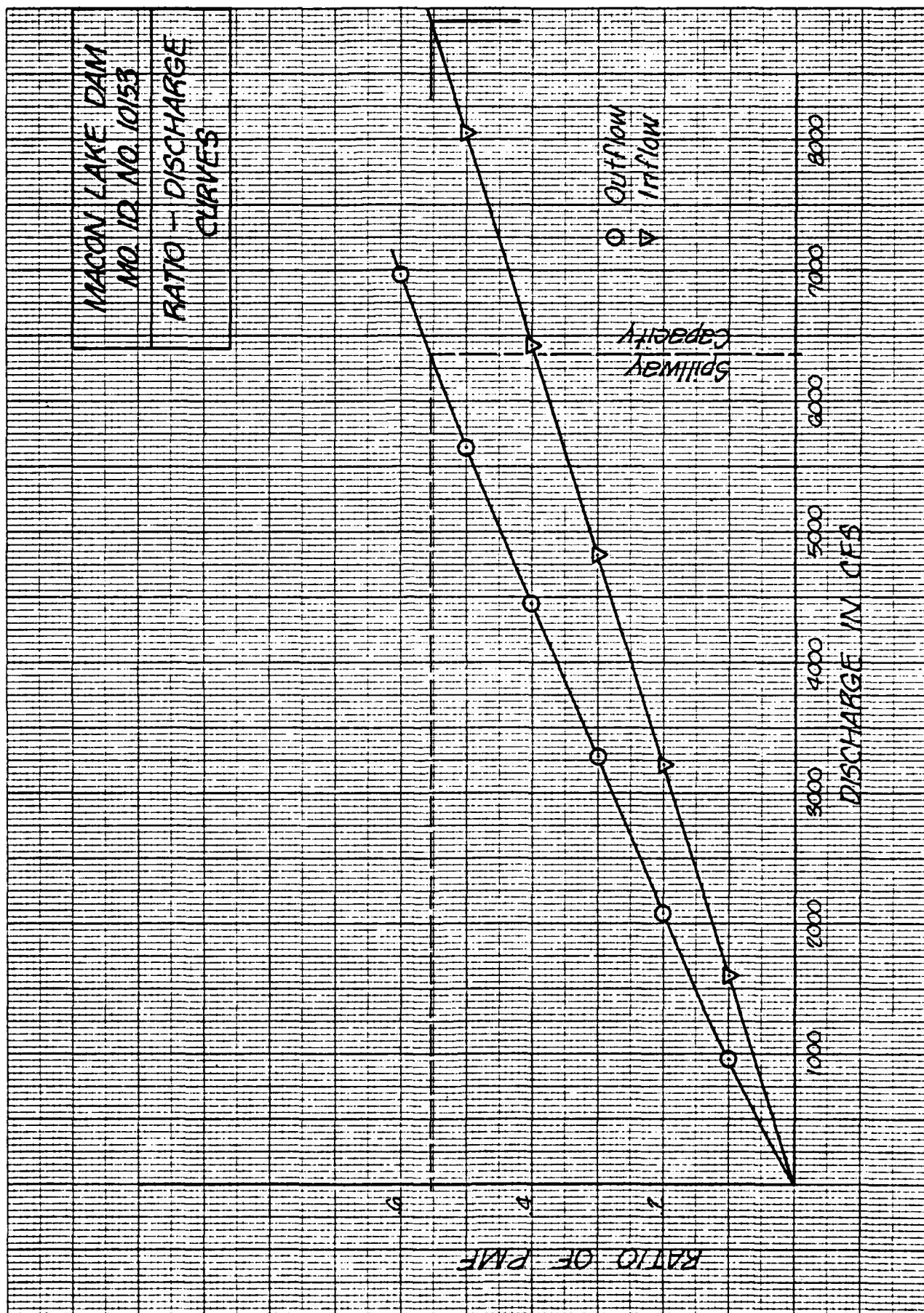
1. The SCS dimensionless unit hydrograph and the systemized computer program HEC-1 (Dam Safety Version), July 1978, prepared by the Hydrologic Engineering Center, U.S. Corps of Engineers, Davis, California, were used to develop the inflow hydrographs (See this Appendix).
 - a. Forty-eight hour, one percent probabilistic rainfall for the dam location was taken from the data for the rainfall station at Moberly, MO. as supplied by the St. Louis District, Corps of Engineers per their letter dated 4 March 1980. The forty-eight hour probable maximum precipitation was taken from the curves of Hydrometeorological Report No. 33 and current Corps of Engineers and St. Louis policy and guidance for hydraulics and hydrology.
 - b. Drainage area = 6.32 square miles (4,048 acres).
 - c. Time of concentration of runoff = 6.1 hours computed from the "Kirpich" formula by totaling the individual computations of six separate sections. This compares to 6.3 hours as computed from California Dept. of Highways culvert formula.
 - d. The antecedent storm conditions for the probable maximum precipitation were heavy rainfall and low temperatures which occurred on the previous 5 days (SCS AMC III). The antecedent storm conditions for the one percent probabilistic precipitation were an average of the conditions which have preceded the occurrence of the maximum annual flood on numerous watersheds (SCS AMC II). The initial pool elevation was assumed at the invert of the principal spillway for the PMF and 1 percent probability floods.
 - e. The total forty-eight hour storm duration losses for the one percent probabilistic storm were 2.52 inches. The total losses for the PMF storm were 1.16 inches. These data are based on SCS runoff curve No. 79 and No. 91 for antecedent moisture conditions SCS AMC II and AMC III respectively. The watershed is composed primarily of SCS soil groups C and D. Land use is approximately 80% wooded with the remainder divided equally into cultivation and in grass land.
 - f. Average soil loss rates = 0.02 inch per hour approximately (For PMF storm, AMC III).
2. The combined discharge rating consisted of two components: the flow through the principal spillway and the flow going over the top of the dam.
 - a. The principal spillway rating was developed by using the weir flow equation.

- 1) Weir Flow equation ($Q = CLH^{1.5}$)
where C = weir coefficient = 3.3 to 3.5 (USGS TWRI, Bk-3,
Ch. A-5, Table 4 - Weir Shape #12)
L = effective weir length, ft. = 85
H = total head, ft.

- b. The flows over the dam were determined by using the dam overtopping analyses (irregular top of dam) within the HEC-1 (Dam Safety Version) program.
3. Floods were routed through the reservoir using the HEC-1 (Dam Safety Version) program to determine the capabilities of the spillway and dam embankment crest. The input, output and plotted hydrographs are attached in this Appendix.







 FLOOD HYDROGRAPH PACKAGE (HEC-1)
 DAM SAFETY VERSION JULY 1978
 LAST MODIFICATION 26 FEB 79

RUN DATE# 80/10/24.
 TIME# 17.43.11.

MACON LAKE DAM / MO. 10 NO. 10153
 SAFETY ANALYSIS OF DAM OVERTOPPING USING ASSIGNED FLOOD FREQUENCIES
 N & H ANALYSIS BY ROUTING PMF RATIOS THRU THE RESERVOIR

JOB SPECIFICATION									
NQ	NHR	NMIN	IDAY	IHR	IMIN	METRE	IPLT	IPRT	NSTAN
240	0	15	0	0	0	0	0	3	0
		JOPER	5	NWT	LROPT	TRACE			
				0	0	0			

MULTI-PLAN ANALYSES TO BE PERFORMED
 NPLAN= 1 NRATIO= 0 LRTIO= 1

RTIOS= .10 .20 .30 .40 .50 .60 .85 1.00

SUB-AREA RUNOFF COMPUTATION

CALCULATION OF INFLO HYDRO TO MACON LAKE

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
000001	0	0	0	0	0	1	0	0

HYDROGRAPH DATA									
IHYDG	IUNG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	2	6.32	0.00	6.32	1.00	0.000	0	1	0

PRECIP DATA									
SPFE	PMS	R6	R12	R24	R48	R72	R96		
0.00	24.20	102.00	121.00	130.00	140.00	0.00	0.00		

LOSS DATA										
LROPT	STKR	DLTKR	RTIOL	ERAIN	STIRK	RTIOL	SIRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	-1.00	-91.00	0.00	0.00

CURVE NO = -91.00 WETNESS = -1.00 EFFECT CN = 91.00

UNIT HYDROGRAPH DATA
 TC= 0.00 LAG= 3.70

RECESSION DATA
 STRIQ= 0.00 GRCSN= -.01 RTIOR= 1.00

UNIT HYDROGRAPH 76 END OF PERIOD ORDINATES, TC= 0.00 HOURS, LAG= 3.70									
16.	41.	78.	124.	177.	240.	321.	410.	509.	595.
671.	728.	766.	791.	796.	794.	785.	753.	719.	682.
640.	592.	539.	477.	420.	368.	331.	297.	265.	239.
216.	197.	178.	160.	144.	129.	114.	104.	93.	84.

[illegible]

1.02	5.15	117	.04	.03	.00	492.	1.03	11.35	237	0.00	0.00	0.00	161.
1.02	5.45	119	.04	.03	.00	439.	1.03	11.45	240	0.00	0.00	0.00	161.
1.02	6.00	120	.04	.03	.00	443.	1.03	12.00					
SUM 33.88 32.72 1.16 534723 (861.) (831.) (29.) (1541.67)													

PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
16100.	12941.	5216.	2228.	534645.
456.	148.	148.	2228.	15133.
CFS	1366.	30.71	32.79	132.79
CMS	19.05	779.27	832.84	832.84
INCHES	463.93	10345.	11046.	11046.
MM	6411.	12761.	13626.	13626.
AC-FT	7916.			
THOUS CU M				

HYDROGRAPH AT STA000001 FOR PLAN 1, RTIO 1

PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
1610.	1294.	522.	223.	53464.
46.	37.	15.	6.	1514.
CFS	1.50	3.07	3.28	3.28
CMS	48.38	78.00	83.28	83.28
INCHES	642.	1035.	1105.	1105.
MM	792.	1276.	1363.	1363.
AC-FT				
THOUS CU M				

HYDROGRAPH AT STA000001 FOR PLAN 1, RTIO 2

PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
3220.	2588.	1043.	446.	106222.
91.	39.	12.	6.	3028.
CFS	3.78	6.34	6.56	6.56
CMS	96.17	156.99	166.87	166.87
INCHES	1283.	2069.	2209.	2209.
MM	1583.	2552.	2725.	2725.
AC-FT				
THOUS CU M				

HYDROGRAPH AT STA000001 FOR PLAN 1, RTIO 3

PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
4830.	3882.	1565.	668.	160323.
137.	110.	44.	19.	4542.
CFS	5.71	9.21	9.84	9.84
CMS	145.15	233.99	249.85	249.85
INCHES	1925.	3104.	3314.	3314.
MM	2375.	3628.	4088.	4088.
AC-FT				
THOUS CU M				

HYDROGRAPH AT STA000001 FOR PLAN 1, RTIO 4

PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
6440.	5177.	2086.	891.	213858.
182.	147.	53.	25.	6056.
CFS	7.62	12.28	13.12	13.12
CMS	193.53	311.99	333.14	333.14
INCHES	2567.	41138.	4419.	4419.
MM				
AC-FT				

THOUS CU M

3166. 5104. 5450. 5450.

HYDROGRAPH AT STA000001 FOR PLAN 1, RTIO 5 [1/2 PMF]

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	8050.	6471.	2608.	1114.	267322.
CMFS	228.	181.	74.	32.	7570.
INCHES		9.52	15.35	16.39	
MM		241.91	389.39	416.42	
AC-FT		3209.	5173.	5523.	
THOUS CU M		3958.	6380.	6813.	

HYDROGRAPH AT STA000001 FOR PLAN 1, RTIO 6

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	9650.	7765.	3129.	1337.	320787.
CMFS	274.	220.	89.	38.	9084.
INCHES		11.43	18.42	19.67	
MM		290.30	467.98	499.70	
AC-FT		3850.	6207.	6628.	
THOUS CU M		4749.	7656.	8175.	

HYDROGRAPH AT STA000001 FOR PLAN 1, RTIO 7

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	13685.	11000.	4433.	1894.	454448.
CMFS	388.	311.	122.	54.	12869.
INCHES		16.19	26.9	27.87	
MM		411.25	662.97	707.91	
AC-FT		5455.	8793.	9389.	
THOUS CU M		6720.	10846.	11582.	

HYDROGRAPH AT STA000001 FOR PLAN 1, RTIO 8 [PMF]

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	16100.	12941.	5216.	2228.	534645.
CMFS	456.	366.	148.	63.	15139.
INCHES		19.05	30.71	32.79	
MM		483.83	779.37	832.84	
AC-FT		6417.	10345.	11046.	
THOUS CU M		7916.	12761.	13626.	

HYDROGRAPH ROUTING

ROUTED FLOWS THRU MACON LAKE

ISTAQ ICOMP IECON ITAPE JPLT JPRT INAME ISTAGE IAUTO

000002 1 0 0 2 0 1 0 0

STATION 63002, PLAN 1, RATIO 5
END-OF-PERIOD HYDROGRAPH ORDINATES $\frac{1}{2} \text{ PMF}$ [illegible][illegible]

Figure 1 displays a sequence of 20 grayscale images arranged in two rows of 10. The top row shows a handwritten digit '9' being formed by a single stroke, with the stroke starting from the left and moving towards the right. The bottom row shows the digit '9' formed by multiple strokes, with the strokes starting from the left and moving towards the right. The images are labeled with numbers 1 through 20, indicating the progression of the digit's formation.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL
CESS	5638.	5013.	2494.	1052.	25423.
CFSS	160.	1423.	70.	30.	7140.
INCHES		7.40	4.63	15.48	15.48
CU FT		187.1	371.48	393.1	332.21
THOUS CU YD		3066.	4607.	6433.	52433.

STATION0000002

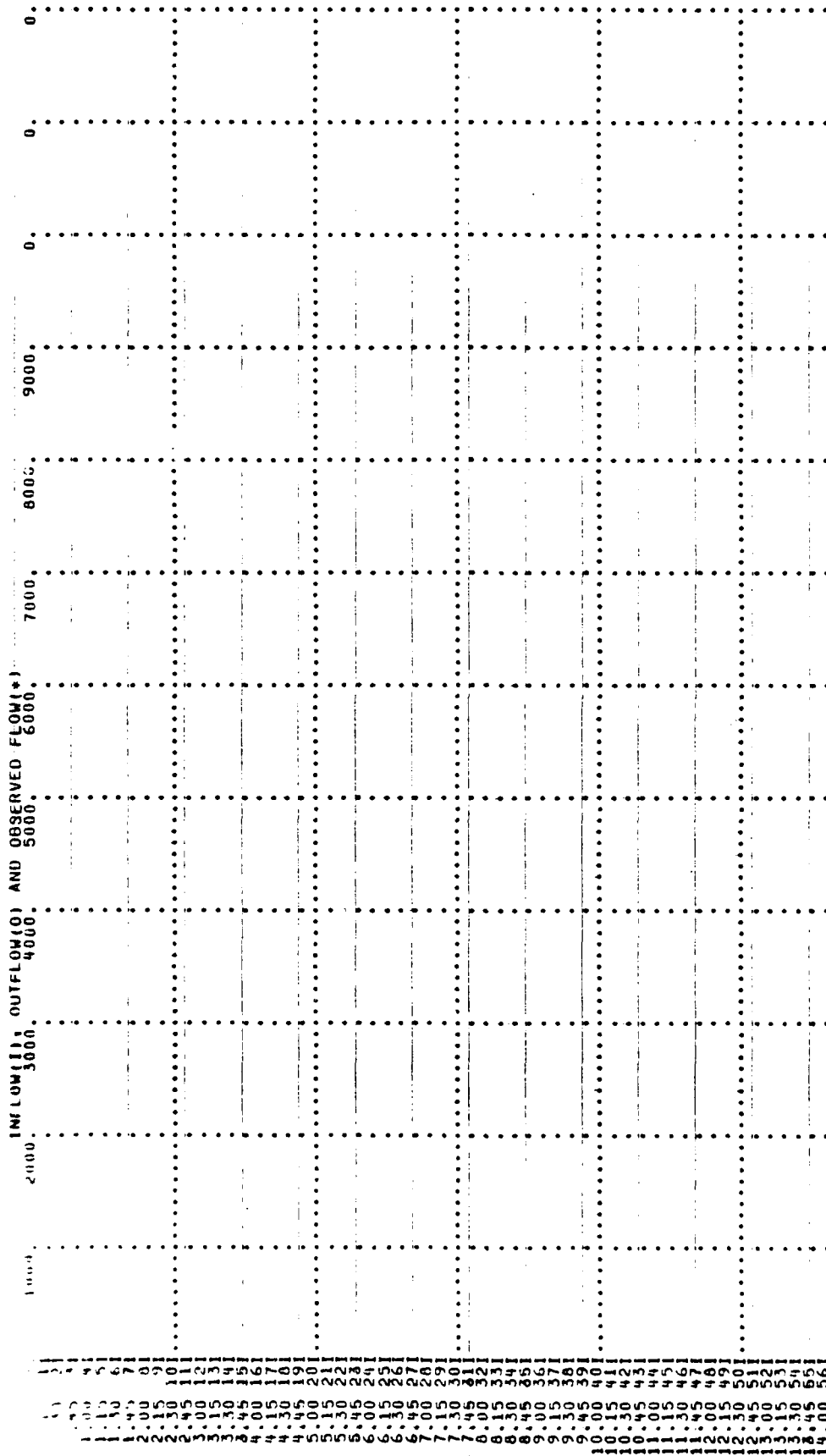
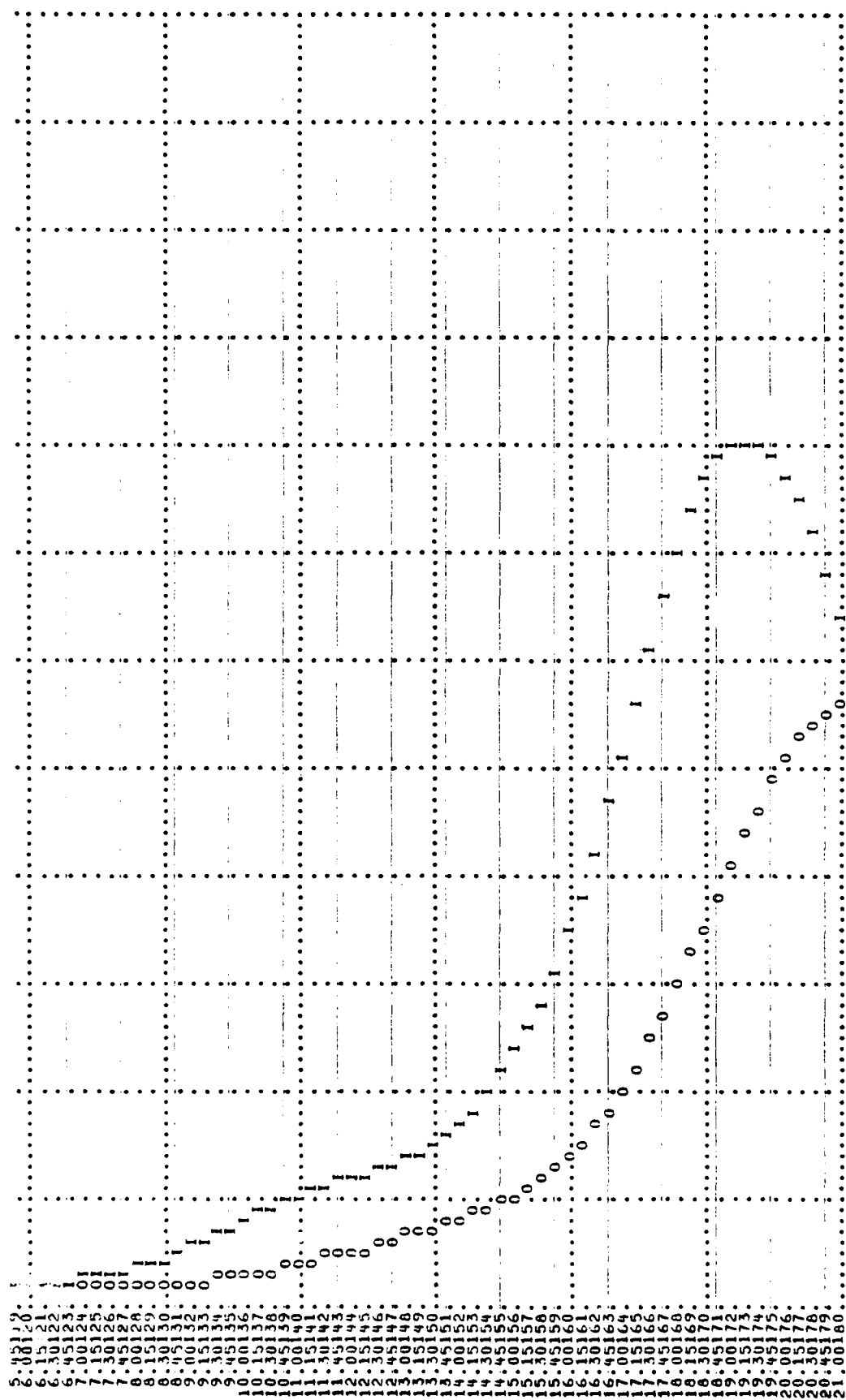


PLATE D-16



STATION 000002, PLAN 1, RATIO 8
END-OF-PERIOD HYDROGRAPH ORDINATES

PLATE D-19

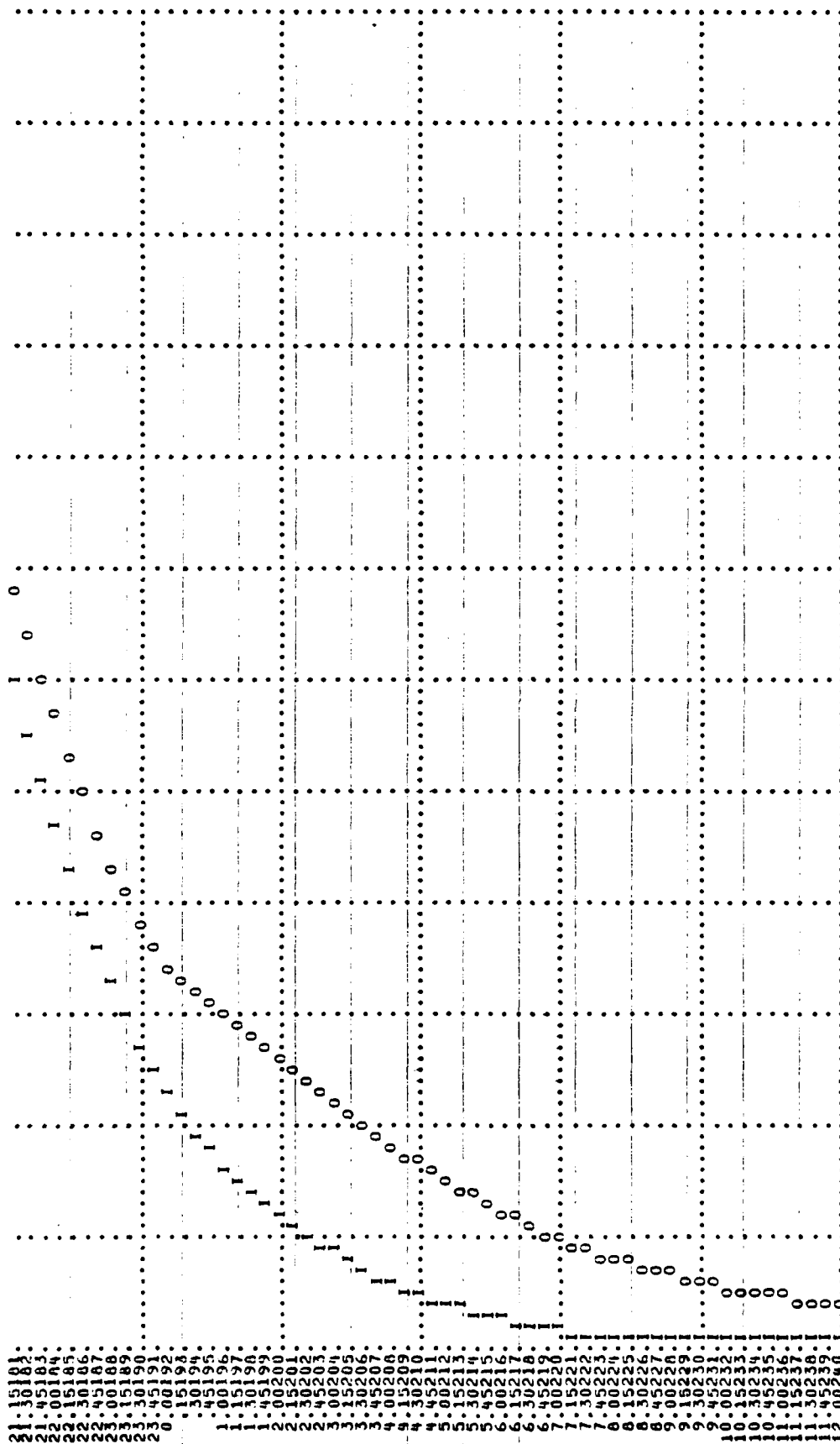
STATION000002

INFLOW(I); OUTFLOW(O) AND OBSERVED FLOW(*)

The image shows a blank grid for plotting data. The vertical axis is labeled 'INFLUENCE OF AND OBSERVED' and has major tick marks at 2000, 4000, 6000, 8000, 10000, 12000, 14000, 16000, and 18000. The horizontal axis is labeled 'COM' and has major tick marks at 0, 1000, 2000, 3000, 4000, 5000, 6000, 7000, 8000, 9000, 10000, 11000, 12000, 13000, 14000, 15000, 16000, 17000, 18000, 19000, 20000, 21000, 22000, 23000, 24000, 25000, 26000, 27000, 28000, 29000, 30000, 31000, 32000, 33000, 34000, 35000, 36000, 37000, 38000, 39000, 40000, 41000, 42000, 43000, 44000, 45000, 46000, 47000, 48000, 49000, 50000, 51000, 52000, 53000, 54000, 55000, 56000, 57000, 58000, 59000, 60000, 61000, 62000, 63000, 64000, 65000, 66000, 67000, 68000, 69000, 70000, 71000, 72000, 73000, 74000, 75000, 76000, 77000, 78000, 79000, 80000, 81000, 82000, 83000, 84000, 85000, 86000, 87000, 88000, 89000, 90000, 91000, 92000, 93000, 94000, 95000, 96000, 97000, 98000, 99000, 100000. The grid consists of solid lines for the major axes and dotted lines for the minor grid.

PLATE D-22

5. 40.15022
 6. 40.15023
 7. 40.15024
 8. 40.15025
 9. 40.15026
 10. 40.15027
 11. 40.15028
 12. 40.15029
 13. 40.15030
 14. 40.15031
 15. 40.15032
 16. 40.15033
 17. 40.15034
 18. 40.15035
 19. 40.15036
 20. 40.15037
 21. 40.15038
 22. 40.15039
 23. 40.15040
 24. 40.15041
 25. 40.15042
 26. 40.15043
 27. 40.15044
 28. 40.15045
 29. 40.15046
 30. 40.15047
 31. 40.15048
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 33. 40.15050
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 51. 40.15068
 52. 40.15069
 53. 40.15070
 54. 40.15071
 55. 40.15072
 56. 40.15073
 57. 40.15074
 58. 40.15075
 59. 40.15076
 60. 40.15077
 61. 40.15078
 62. 40.15079
 63. 40.15080



PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
 FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
 AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS							
				RATIO 1	RATIO 2	RATIO 3	RATIO 4	RATIO 5	RATIO 6	RATIO 7	RATIO 8
				.10	.20	.30	.40	.50	.60	.85	1.00
HYDROGRAPH AT	000001	6.32 (16.37)	1	1610 (45.59)	3220 (91.18)	4830 (136.77)	6440 (182.36)	8050 (227.94)	9660 (273.53)	13685 (387.51)	16100 (455.89)
ROUTED TO	000002	6.32 (16.37)	1	965 (27.31)	2078 (58.83)	3257 (92.23)	4450 (126.00)	5638 (159.65)	6969 (197.35)	12421 (351.73)	15285 (432.82)

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1	ELEVATION STORAGE OUTFLOW	INITIAL VALUE 791.90 2248. 0.	SPILLWAY CREST 791.90 2248. 0.	TOP OF DAM 799.90 4404. 6350.			
RATIO OF PMF	MAXIMUM RESERVOIR W.S. ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.10	794.11	0.00	2738.	965.	0.00	46.00	0.00
.20	795.70	0.00	3139.	2078.	0.00	45.75	0.00
.30	797.02	0.00	3503.	3257.	0.00	45.50	0.00
.40	798.20	0.00	3853.	4450.	0.00	45.50	0.00
.50	799.26	0.00	4121.	5629.	0.00	45.50	0.00
.60	800.24	0.34	4520.	6969.	2.25	45.25	0.00
.85	801.34	1.44	4909.	12421.	5.50	44.25	0.00
1.00	801.71	1.81	5046.	15285.	6.75	44.00	0.00

**DATA
FILM**